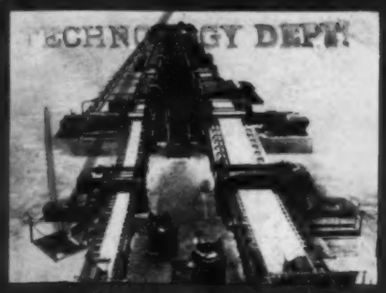
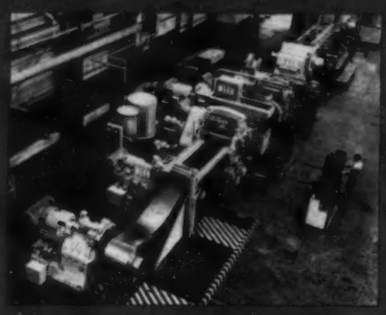
Iron AND Steel ENGINEER

ENGINEERING SERVICE
TO THE IRON AND STEEL
INDUSTRY SINCE 1907

JULY 19-5 PITTSBURGH, PA.



Pickle Line


Electrolytic Line

Annealing

Hi-Speed Modern and Streamlined

The Wean Engineering Company has translat... these essentials into sheet, tin and strip mill ...p-ment having increased productivity and so ...gedly constructed as to reduce maintenance to a ...imum.

Modern Wean-designed equipment ...erforming smoothly and efficiently in your pl... will help overcome the now unbalanced relati... of labor costs to the average price of finished st...

SPECIALISTS IN SHEET, TIN AND STRIP MILL EQUIPMENT

The WEAN ENGINEERING COMPANY, Inc. • WARREN, OHIO

Subsidiary Company THE BRODEN CONSTRUCTION COMPANY • Cleveland, Ohio

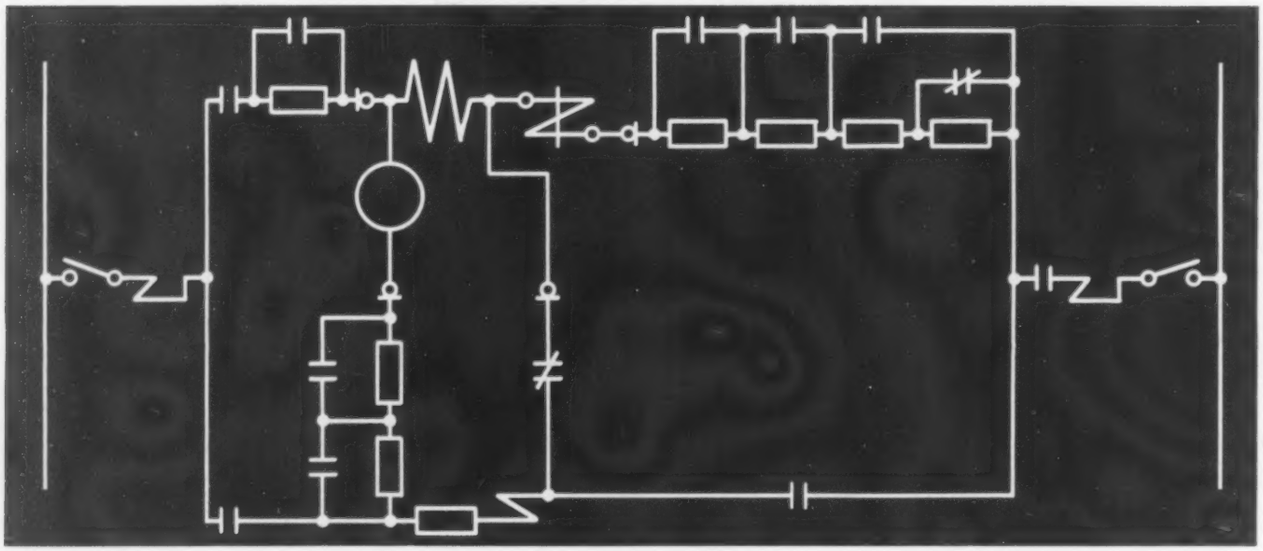
N.23a July-Dec. 1946

What control for what mill equipment?

One of a SERIES

of advertisements featuring basic heavy duty power circuits . . . and showing Cutler-Hammer's broad design and application experience which has made it *the* preferred control for the steel industry.

D.C. dynamic braking hoist control



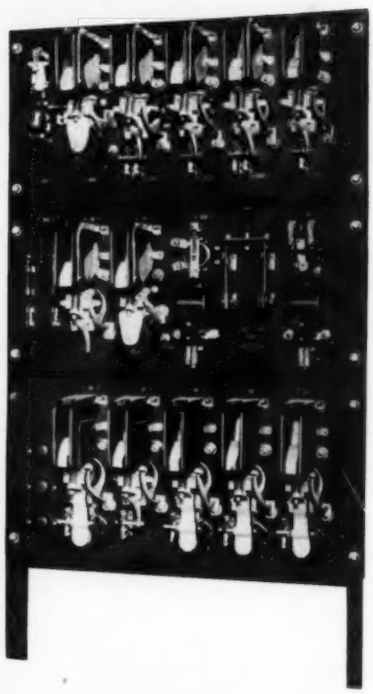
When you have an installation such as a crane hoist or winch where the load may be overhauling and requirements dictate a series motor with dynamic braking . . .

Here . . . use Cutler-Hammer No. 14115 Control

Lt1 ACCELERATION and DECELERATION . . Cutler-Hammer Bulletin No. 14115 provides 5-point inductive time limit acceleration in the hoisting direction for smooth swift take-up of cable slack, equally smooth acceleration and hoisting of loads with a choice of five speeds. Bulletin 14115 also provides inductive time limit acceleration and deceleration in the lowering direction for full speed and safety in lowering all loads and high speed lowering of the empty hook. It provides off-position dynamic braking to assist magnetic brake in stopping the load. It prevents excessive current peaks. It employs dependable constant timing Lt1 contactors which have a coarse and micrometer timing adjustment, not affected by dust and dirt. It is simple, always provides smooth, uniform response to the master, and is trouble-free. Inductive time limit control is another Cutler-Hammer "original' which has been copied but never equalled.

EQUIPMENT . . . Conforming to NEMA standards. Available in ratings up to 1800 amperes—open or enclosed. Also a complete line of control accessories.

VITAL ENGINEERING EXPERIENCE . . . When you specify Cutler-Hammer control for your cranes, ore bridges, etc., you specify more than the physical components. You benefit by a 50-year background of broad and exhaustive experience among the steel mills of America, assuring correct design, and world-famous dependability. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer Ltd., Toronto.



TYPICAL COMPONENTS of CUTLER-HAMMER MILL CONTROL

Crane Safety Limit Stop
Snap action, low headroom. Totally enclosed tripping mechanism, operating lever and tripping weight combined. Mountable in 4 quadrants.

Mill Brake
The simplest, hence the most direct, hence the most efficient of all mill brakes. Hardened steel wheels ground to smooth finish.

Lifting Magnets
Vacuum impregnated with special Cutler-Hammer high temperature compounds. Strap-wound coils. Watertight sealing disk, waterproof terminal box.

CUTLER-HAMMER
MOTOR CONTROL
C-H

TAKE THE STEEL INDUSTRY

OR BRASS · OR COPPER · OR ALUMINUM

Jot down a list of efficient producers in each.
Chances are, Aetna-Standard has built machinery for all the companies, large or small.
In mill machinery, Aetna-Standard ranks at the top in several classifications. For example:

- Seamless Tube Mills
- Continuous Buttweld Pipe Mills
- Coating Equipment, Continuous Galvanizing and Tinning
- Drawbenches
- Mill Tables and Cooling Beds
- Flat Rolled Finishing Equipment

The testimonials and repeat business we inspire spring from knowledge of product and procedure plus the ability to design and build better equipment.

To maintain this confidence, we devote a part of our energies to the future. It's sound business on our part to have the needs of industry constantly under observation. When we see a need, we study, experiment, and test... before we say to industry—"we have something for you."

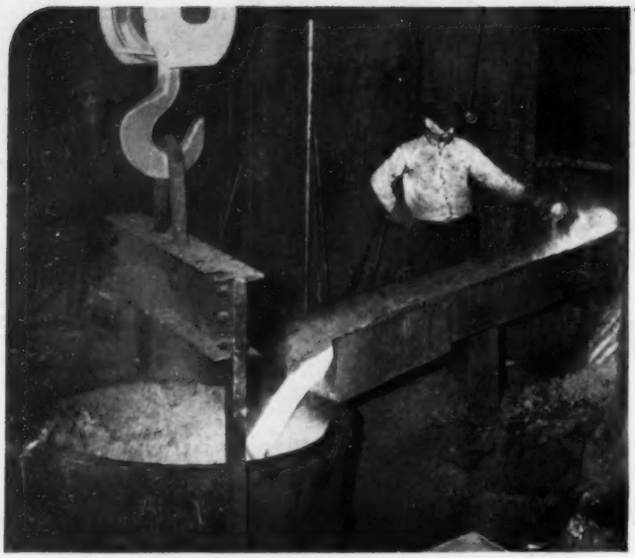
Converting ideas into productive production, that is, making machinery to efficiently produce, form, and process steel, brass, copper or aluminum, is our business.

THE AETNA-STANDARD ENGINEERING COMPANY
275 W. FEDERAL STREET
YOUNGSTOWN, OHIO

ASSOCIATED COMPANY: HEAD, WRIGHTSON & COMPANY, LIMITED, MIDDLESBOROUGH, ENGLAND

DESIGNERS AND BUILDERS to the Steel, Non-Ferrous and Chemical Industries.

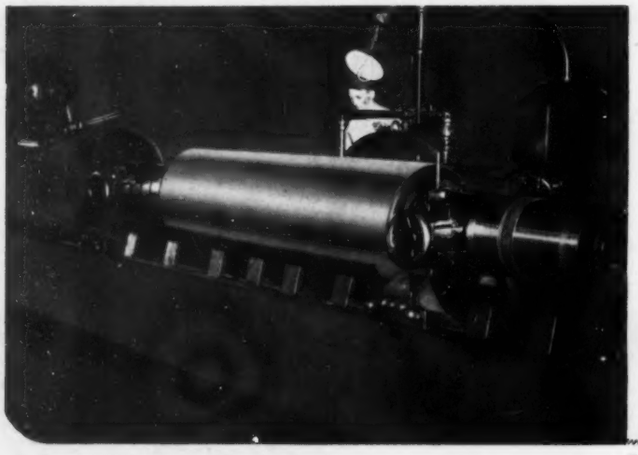
Aetna-Standard



THE HEAT IS ON! Tapping a heat of alloy iron in the National foundry. Samples of each heat are rushed to laboratory for metallurgical analysis.

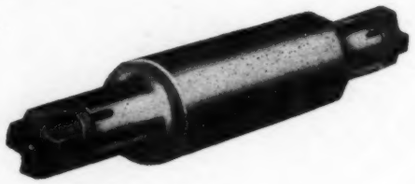
PORTAL OF PROTECTION! The entryway to National's modern laboratories where metallurgical guesswork is eliminated—where research for new and better iron and steel alloys is a never-ending task.

MODERN MACHINE TOOLS! Finish roll grinder of latest design in use in National shop. Modern machining facilities speed production, assure dimensional accuracy.



MADE RIGHT TO ROLL RIGHT

Modern manufacturing facilities, combined with exacting laboratory analysis of materials and careful inspection, make each National Roll *right* for its specified purpose. Rigid quality control guides every step in manufacture. There can be no compromise with correct metallurgical composition—no variance from closely held tolerances in machined surfaces. Maximum strength and durability are assured. For rolls of the highest quality, *specify National.* They are made right to roll right.



National Rolls

THE NATIONAL ROLL & FOUNDRY CO.
AVONMORE, PENNSYLVANIA

Manufacturers of IRON AND ALLOY IRON ROLLS

L.B-50
Record Binding.

NO TRIM

Iron and
Steel
Engineer

23
Part 2

July-Dec.
1946

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~~Index in Dec.~~

Trim lightly, and if the book has been trimmed before do not cut at all.
Bind everything in as laid.
Follow copy in arrangement and punctuation, and return this slip with the bound volume.

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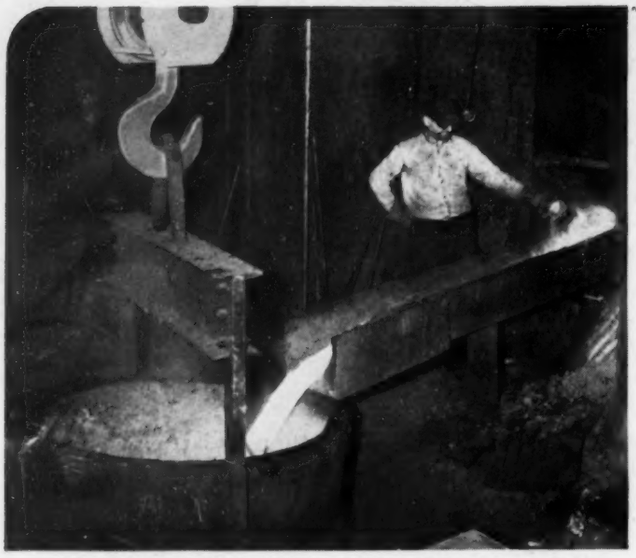
FORM B1-2 TECHNOLOGY DEPARTMENT



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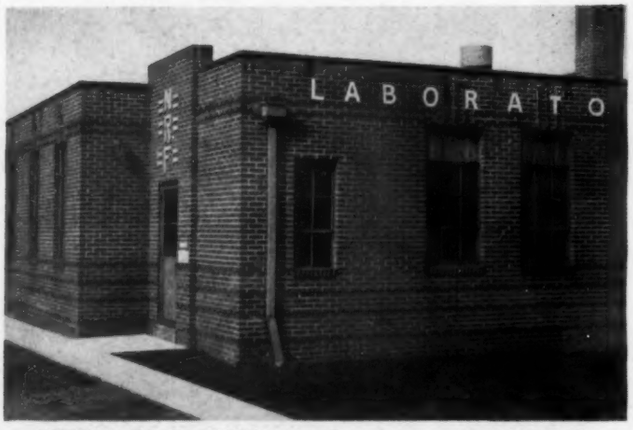

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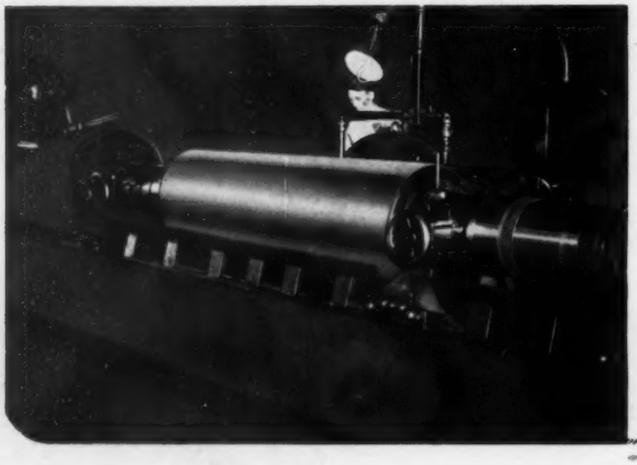

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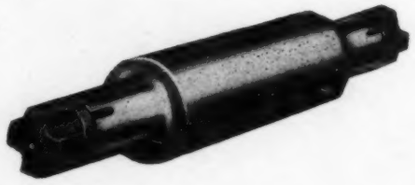


National Rolls

THE NATIONAL ROLL & FOUNDRY CO.
AVONMORE, PENNSYLVANIA

Manufacturers of IRON AND ALLOY IRON ROLLS

Just Darn Good Blocks

Heppenstall Die Blocks are naturally expected to give, *and do give*, a substantial margin of extra service. Heppenstall Co., Pittsburgh, Pa.

Heppenstall

the most dependable name in die blocks

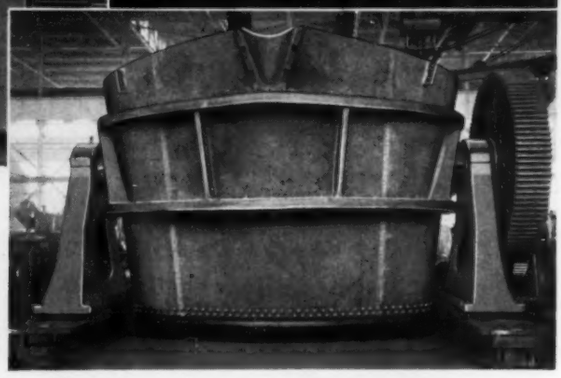
FOR *HOT* METAL APPLICATIONS

EC&M CONTROL

offers

MANY ADVANTAGES

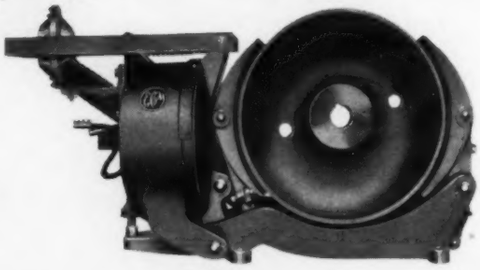
● 175-Ton Hot Metal Holding Ladle built by Treadwell Construction Co., Midland, Pa.



★ Wherever hot metal is stored, handled or processed, many firms, acquainted with EC&M value, select this quality apparatus because of their confidence in it—in the engineering and experience which it represents.

Typical hot metal applications include: (1) Ladle Cranes, (2) Hot Metal Cranes, (3) Hot Metal Mixers, (4) Bessemer Converters, (5) Storage Vessels, (6) Blast Furnace Guns—where only tried and true equipment which represents the utmost in safety and dependability is acceptable.

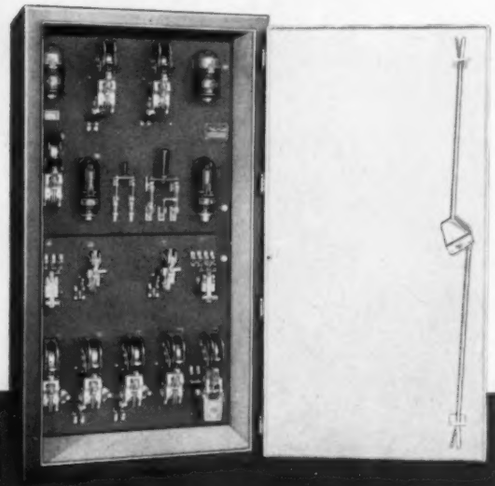
Listed at the left are a few of the EC&M products especially designed for the requirements of hot metal service. They have proved themselves highly successful in many applications throughout the years. Specify EC&M Control for hot metal applications.



● EC&M Air and Magnetically-operated Type WB Brake—normally operated by motor current with air-release for emergency operation.

EC&M EQUIPMENT
Especially Designed for Hot Metal Service

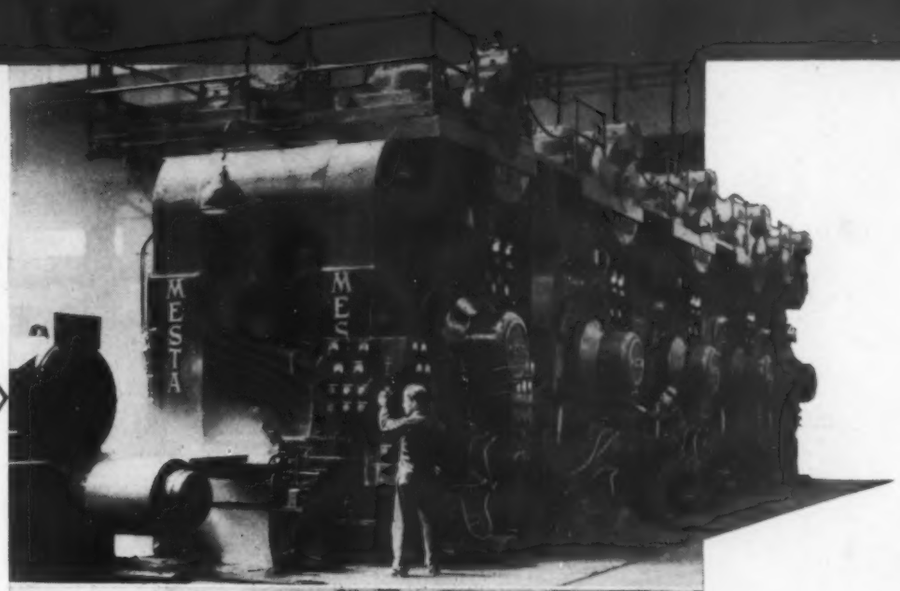
1. EC&M Converter Control System (Patent No. 1,899,586)
2. Dead-Man's Master Switch
3. Air and Magnetically-released Brakes
4. Positive-type Limit Stops for Slowdown and Final Stopping
5. LINE-ARC Magnetic Contactor Controllers.



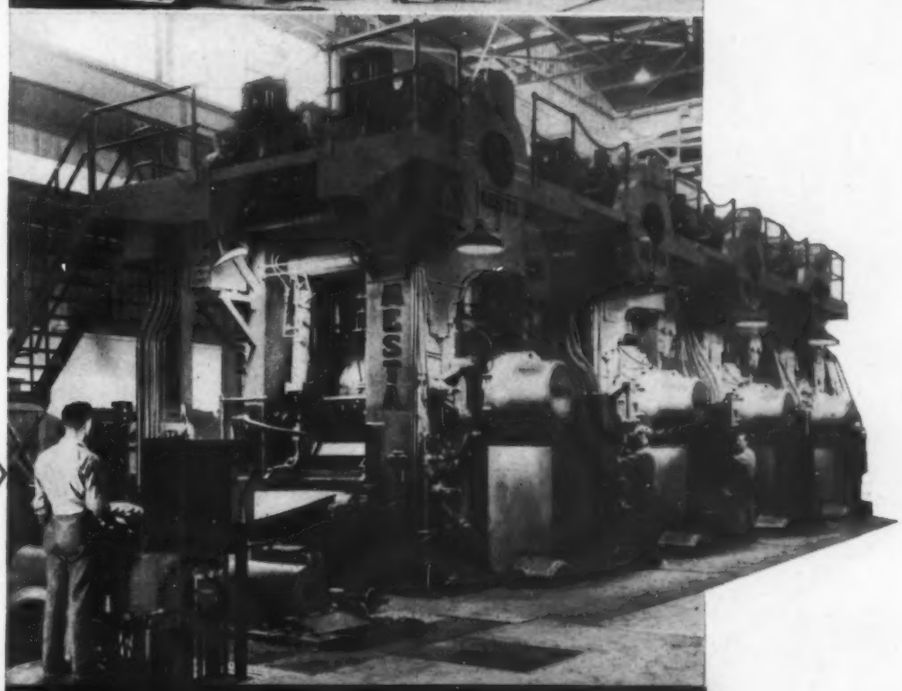
THE ELECTRIC CONTROLLER & MFG. CO.
2700 E. 79th ST. CLEVELAND, OHIO

MESTA

HIGHER SPEED Four-High Tandem COLD MILLS



48" Four-High Five Stand Tandem Cold Mill

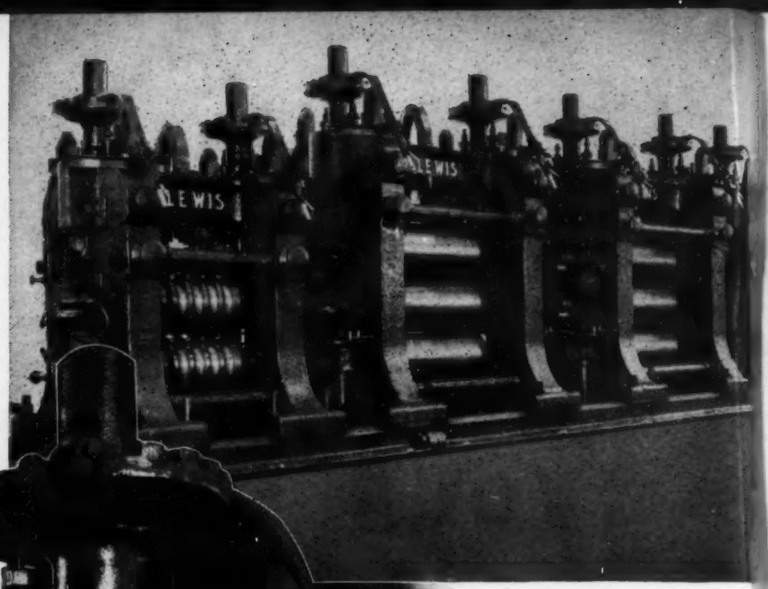


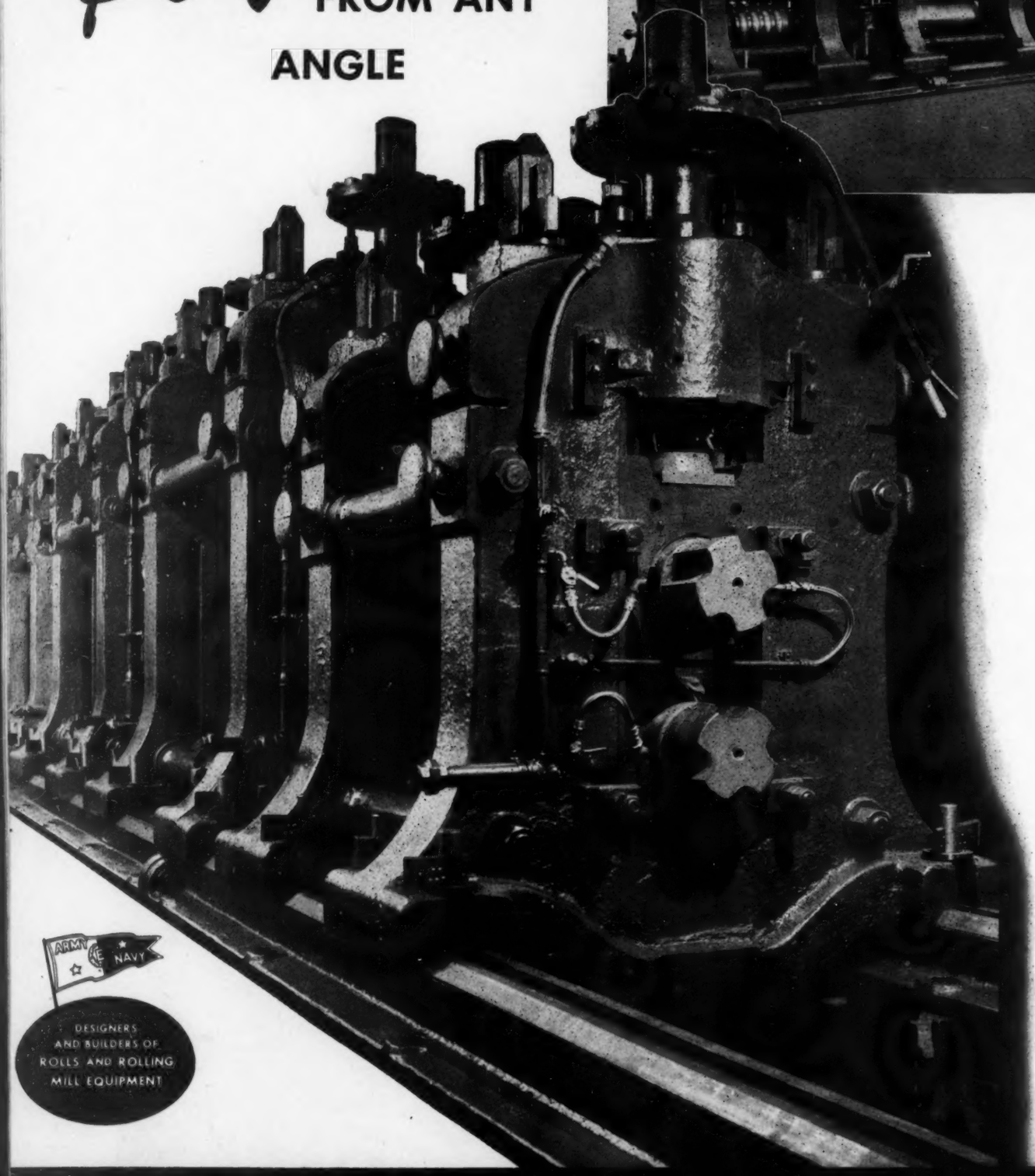
54" Four-High Four Stand Tandem Cold Mill

First in the industry with the Four-High Tandem Cold Tin Mill, Mesta has constantly maintained its position of leadership, and is building mills with delivery speeds which yesterday were considered impossible. These mills feature new types of drives and control systems which maintain synchronization during acceleration, deceleration and at normal operating speeds.

MESTA MACHINE COMPANY • PITTSBURGH, PA.

Perfection FROM ANY ANGLE



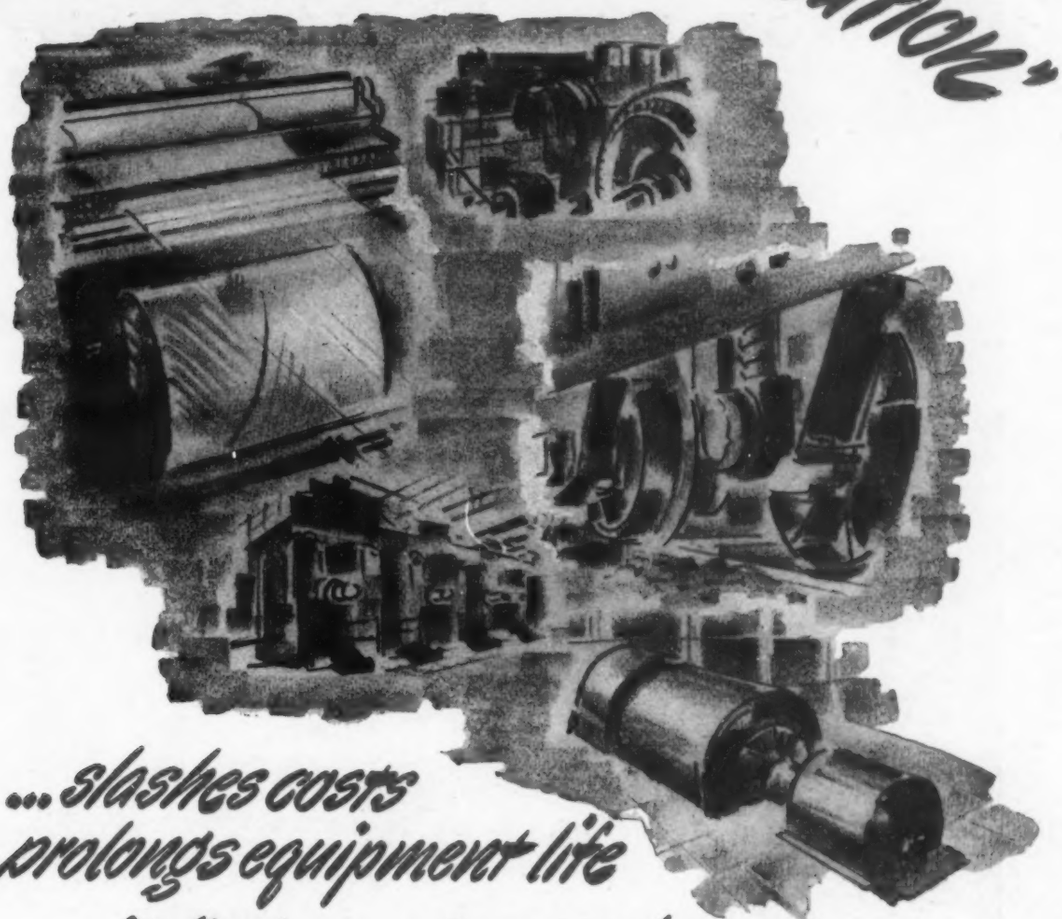


ARMY NAVY

DESIGNERS AND BUILDERS OF ROLLS AND ROLLING MILL EQUIPMENT

LEWIS FOUNDRY & MACHINE
DIVISION OF BLAW-KNOX COMPANY
PITTSBURGH, PA.

Tycol "Engineered Lubrication"



... slashes costs
... prolongs equipment life
... reduces wear and repair

TYCOL DIESEL OIL— Minimizes sticking valves . . . reduces cylinder wear . . . cuts oil consumption.

TYCOL TURBINE OIL–Inhibits rust...resists sludging and emulsification

TYCOL STEAM CYLINDER OIL—Assures economical lubrication at all temperatures . . . supplies superior protection . . . provides longer service.

TYCOL NO-RUST-OL—Protects against rust . . . usable at all temperatures . . . is readily removed in degreasing operations.

TYCOL EXTREME PRESSURE LUBRICANTS– Extremely stable . . . high film strength . . . non-corrosive . . . water resistant.

There's a Tide Water Associated lubricant for every service condition. For aid in the solution of your lubrication problems, get in touch with your nearest Tide Water Associated office today.

LUBRICATION—"ENGINEERED TO FIT THE JOB"

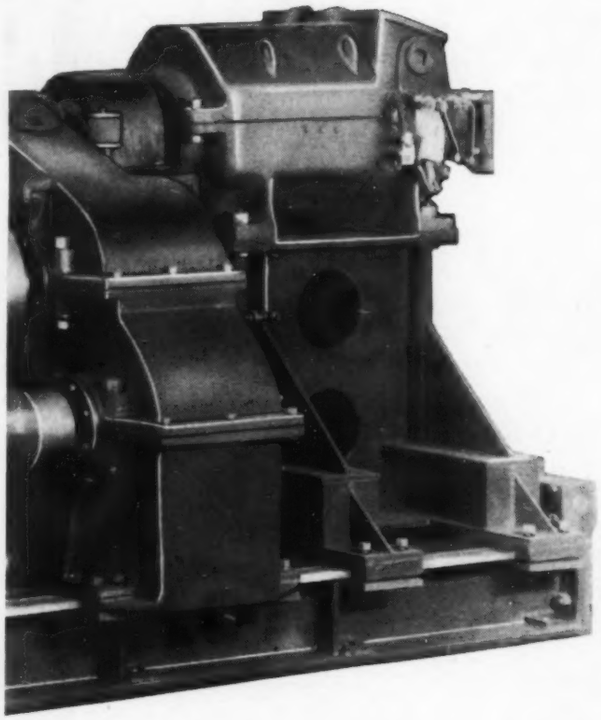
TYCOL
INDUSTRIAL LUBRICANTS

Boston • Charlotte, N. C.
Pittsburgh • Philadelphia

TIDE WATER ASSOCIATED OIL COMPANY
17 BATTERY PLACE · NEW YORK 4, N. Y.

new
Designed with an
BIRDSBORO

4" angle straightener by BIRDSBORO- eye to speed and accuracy.



Here is the latest design in a machine of this type. Because of its patented end roll adjustment, the operator maintains quick and easy control of the rolls while the machine is in operation. This provides for speed in production and holding the work going through to close tolerances.

This machine has four bottom and four top working rolls and is also equipped with a set of vertical idler rolls. The four bottom rolls and one top roll on entry end of machine are driven through universal spindles. The straightening rolls are made up of discs mounted on steel mandrels. Anti-friction bearings are used throughout.

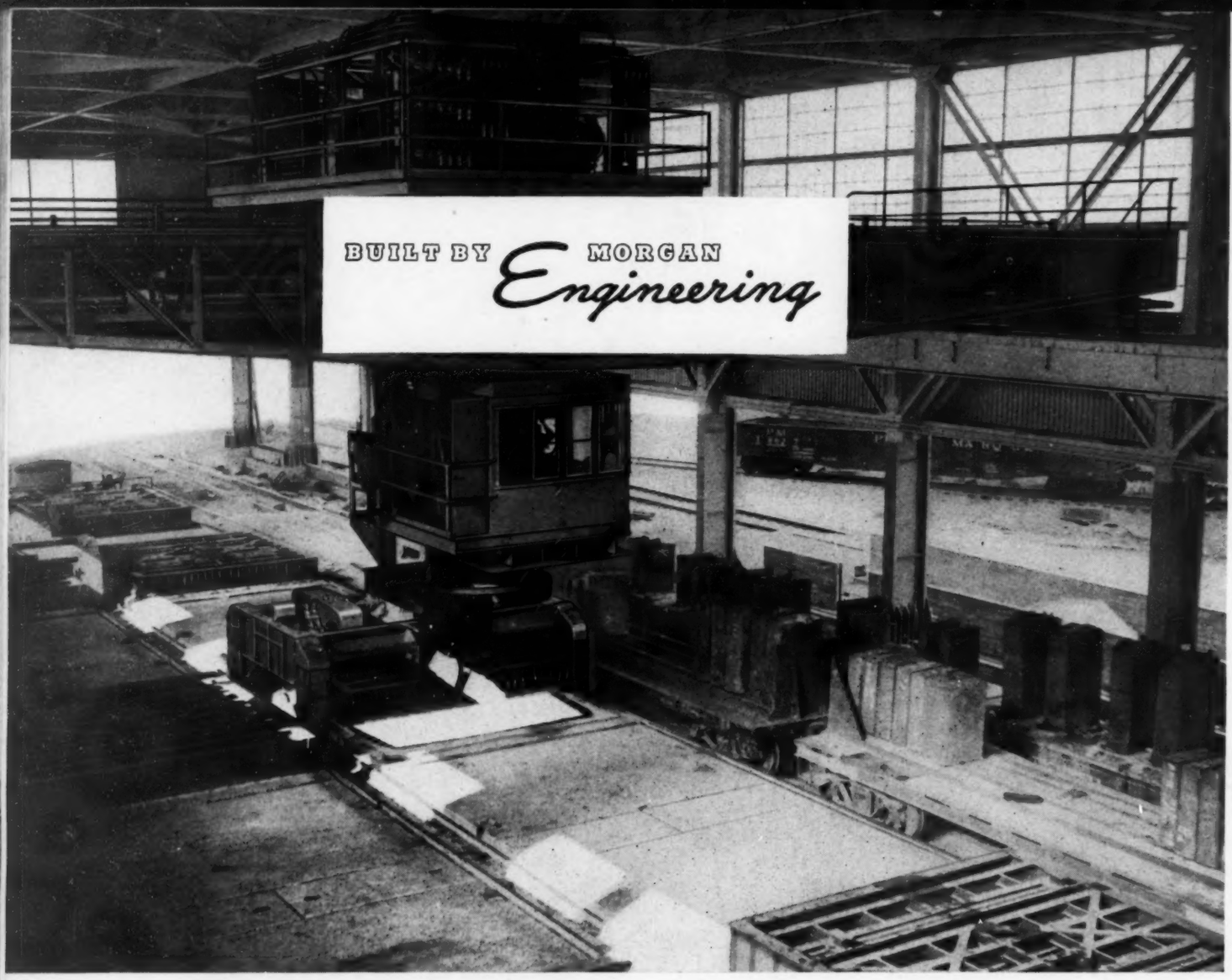
This is another example of the modern development work being done at Birdsboro—an activity you may well investigate when you are thinking of replacing worn-out equipment or adding to your plant facilities. Put your problem into the hands of Birdsboro design-engineers for a practical solution.

BIRDSBORO STEEL FOUNDRY AND MACHINE COMPANY, BIRDSBORO, PA.

Manufacturers of Steel Mill Equipment, Iron and Steel Rolls, Hydraulic Presses, Crushing Machinery, and Special Machinery

BIRDSBORO

STEEL MILL EQUIPMENT



MORGAN 10-TON SOAKING PIT CRANE

HANDLING SLAB INGOTS IN A WEST COAST STEEL PLANT

Illustrated is a Morgan 10-Ton, 7-Motor, 81′ 0″ Span Soaking Pit Crane with 15-Ton Auxiliary Hoist. Morgan superiority of design and construction is built into every part to insure many years of profitable service. It is equipped with fabricated welded trolley and bridge trucks and anti-friction bearings throughout. Trolley is of the worm operated type which simplifies the construction and lowers the cost of maintenance.

THE MORGAN ENGINEERING CO.

ALLIANCE, OHIO. 1420 Oliver Building, Pittsburgh

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

Rolling the kinks out!

STEEL ROUNDS up to 7" and pipes up to 10" diameter snake through this modern Round Straightener at speeds up to hundreds of feet per minute. Kinks and bends are swiftly ironed out. It's a tough, rugged machine—and it's brutal to lubricants!

As kinks and bends hit the rollers, those drive gears shown at left are subjected to extreme shock pressures. Protective oil films are squeezed to the point of rupture. But Gargoyle Compound No. 2 stands up! Specially developed for service in such heavy-duty bath and circulation oiled gear sets, it resists rupture under high tooth pressures, remains stable over long periods, assures maximum protection.

Successful operation of the machine demands that the idler rolls (see details below) run freely, no matter how heavy or light the pressures. Here, Gargoyle Grease Sovarex L-O supplies the answer. It is unusually tenacious—resists change under pressure—maintains its protective lubricating film under heavy shock loads. That is why it is also used in the universals for the driving rolls.

For the answers to tough lubrication problems, look to Gargoyle Oils and Greases!

Illustration prepared with cooperation of Sutton Engineering Company

Get this Complete Lubrication Program for all your machines

- Lubrication Study of your Entire Plant
- Recommendations to Improve Lubrication
- Lubrication Schedules and Controls
- Skilled Engineering Counsel
- Progress Reports of Benefits Obtained

GARGOYLE Lubricants

Socony-Vacuum Oil Co., Inc.

and Affiliates: Magnolia Petroleum Company, General Petroleum Corporation

Exide

IRONCLAD BATTERIES

BUILT FOR PEAK PERFORMANCE AND LONG LIFE IN HEAVY-DUTY SERVICE...

The Exide-Ironclad is a different type of battery . . . in design, construction, service qualities. It was developed to meet the need for a battery to deliver high, sustained power in heavy-duty service over a long period of time.

THE POSITIVE PLATE is unique in battery design. It consists of a series of slotted, vertical, hollow tubes which contain the active material (See illustration at left). The slots in the tubes are so fine that, while they permit easy access to the electrolyte, they prevent the lead oxide from readily washing out, thus adding considerably to the life of the plate.

THE NEGATIVE PLATE has been designed and is built to equal the increased life of the positive plate. Like the positive plate, it has two feet at the bottom to raise it above the two supporting ribs.

SEPARATORS are made of Exide Mipor, a special rubber composition, and will match the long life of Exide-Ironclad plates. The cutaway illustration shows how separators rest on ribs well below bottom of plates, thus making probability of internal short circuits very remote.

THE EXIDE-IRONCLAD ASSEMBLY is sealed in jars of Giant Compound. Jars are practically unbreakable in normal service.

THE RESULT is an efficient, ruggedly built battery that assures dependable performance, long life and maximum economy . . . a battery that fully measures up to each service requirement . . .

★ ***HIGH POWER ABILITY***. . . needed in frequent "stop and go" service.

★ ***HIGH MAINTAINED VOLTAGE*** throughout discharge.

★ ***HIGH ELECTRICAL EFFICIENCY*** that keeps operating costs low.

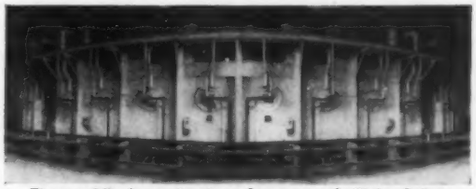
★ ***RUGGED CONSTRUCTION*** . . . for long life.

Exide-Ironclads are supplied in sizes to suit every make and type of electric industrial truck.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32
Exide Batteries of Canada, Limited, Toronto

ENGINEERED HEAT
for production Quality

Salem Engineering Company designs and builds industrial furnaces and heating equipment for production of ferrous and non-ferrous metals . . . for metal fabricating . . . for forging and foundry operations. Where new and revolutionary ideas necessitate ingenious use of heat, Salem engineers survey the problem and "come up" with not only the heating solution, but in many cases, the means of material handling. In short . . . Salem tailors its equipment to a streamlined flow of production.



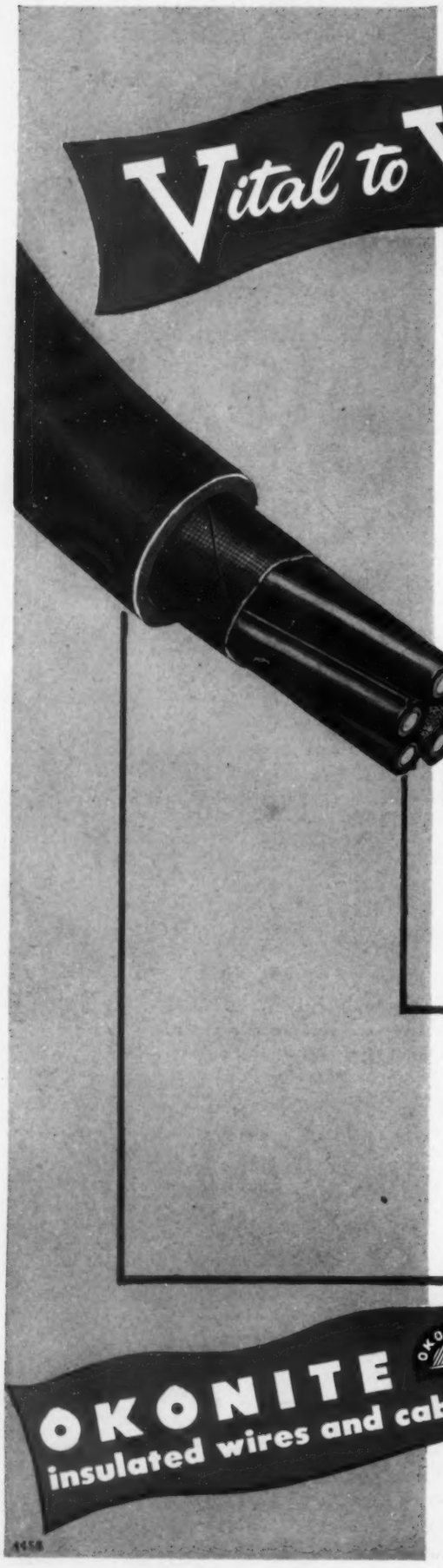
The world's largest rotary furnace . . . built by Salem

Evidence of Salem's experience lies in the world's largest rotary furnace, in all of America's butt weld pipe mills, in all of the circular soaking pits, in all of the small arms ammunition plants, as well as in continuous annealing and heat treating furnaces and batch type ingot heating furnaces operating throughout America and abroad.

A 16-page book entitled "Engineered Heat" is ready for you. Just send your name and address.

SALEM

SALEM ENGINEERING CO.
SALEM, OHIO
TORONTO, ONTARIO, CANADA
LONDON, ENGLAND



Vital to Value today

. . . the *certainty* that it's engineered for long life from conductor to sheath

Present-day costs of installation, present-day charges for repairs put a premium on *getting the best the first time*. So, in selecting a cable, it pays more than ever today to think in terms of the highest quality . . . to look for life-extending features built into the cable. Here is what Okonite-Okoprene* offers.

1 **Okoloy-coated copper conductors** made corrosion-resistant by a continuous coating of a lead alloy developed through Okonite research nearly 20 years ago. Okoloy outlasts "tinning" 2 to 1.

2 **Long-lived Okonite insulation** made with wild up-River fine Para rubber, compounded according to the original formula, applied by Okonite's strip insulating process and vulcanized in a continuous metal mold. Its stable electrical properties have been proved in service over a period of nearly 70 years.

3 **Protective covering of Okoprene,** a neoprene compound developed a dozen years ago by Okonite research to eliminate perishable braids and to seal the insulation from air and sunlight. It not only adds electrical strength but also resists oil, chemicals and ozone. Non-flammable, heat-resistant Okoprene is bonded to the insulation and, in single conductor cables, no other covering is needed.

4 **Tough and durable Okoprene sheath** for additional protection of multi-conductor cables installed underground or in exposed locations. Non-metallic Okoprene jackets resist mechanical injury and cannot be damaged by corrosion and electrolysis.

Talk over your specific needs with an Okonite engineer. Discuss the best cable constructions for the services in which you're interested. The Okonite Company, Passaic, New Jersey.

*U. S. Pat No. 2,312,058

Yesterday's impossibility today's accomplishment

That epitomizes the results obtained in many important mills where F. E. I.-engineered heating equipment is in operation. One such installation, comprising F. E. I. patented Direct-Fired Cover Furnaces, in a large Eastern mill, is shown below. Performance records, from this and other prominent plants, are yours for the asking and speak a language more eloquent than anything else we could say.

F. E. I. specializes in studying existing heating troubles and in submitting recommendations and estimates to meet many new and exacting production objectives in wire, rod, strip, sheet and other mills, steel as well as non-ferrous.

These services of the F. E. I. organization, backed by 30 years of successful experience, are yours for the asking, without cost or obligations. When our recommendations include specific types of equipment not made by ourselves, we are glad to tell you where it may be obtained.

F. E. I. EQUIPMENT

Direct-Fired Cover Furnaces for annealing, spheroidizing, Normalizing and Bright annealing of wire, rods, coiled strip, flat sheets and tin plate.

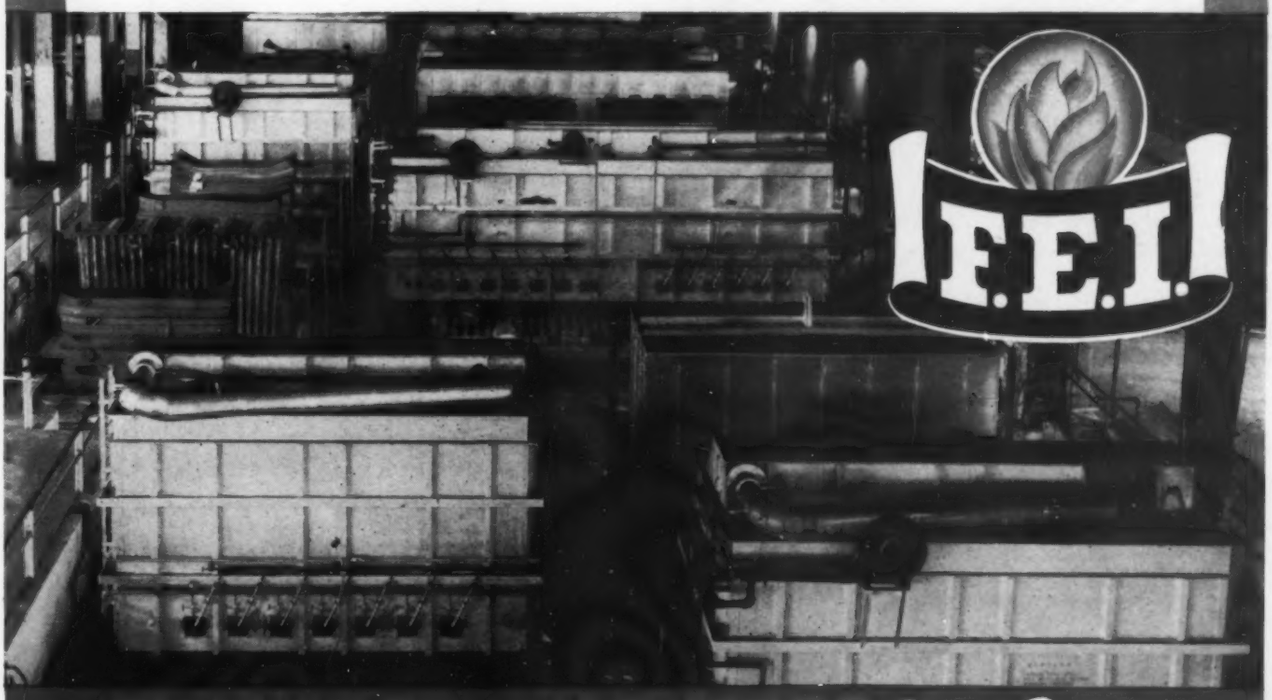
For heavy Coil Loads, patented Convection Base gives 200 to 400% longer service.

For Wire, Bar and Tube Mills: Galvanizing, Patenting and Normalizing Furnaces.

For Pipe, Sheet, and Job Plants: Hot Dip Galvanizing Furnaces.

Car Type Furnaces.

Ladle Heating Furnaces.



FURNACE ENGINEERS, Inc.

Specializing in the design, manufacture and installation of furnaces for the metal working industries

1551 WEST LIBERTY AVENUE ★ PITTSBURGH, PA.

THE BONNOT BILLETEER NEVER SUFFERS GROGGINESS OR JITTERS

Billet-shed production records confirm what safety men and industrial engineers know . . . that the efficiency of manual chippers and scarfers drops rapidly after a few hours work.

FATIGUE INCREASES YOUR COSTS

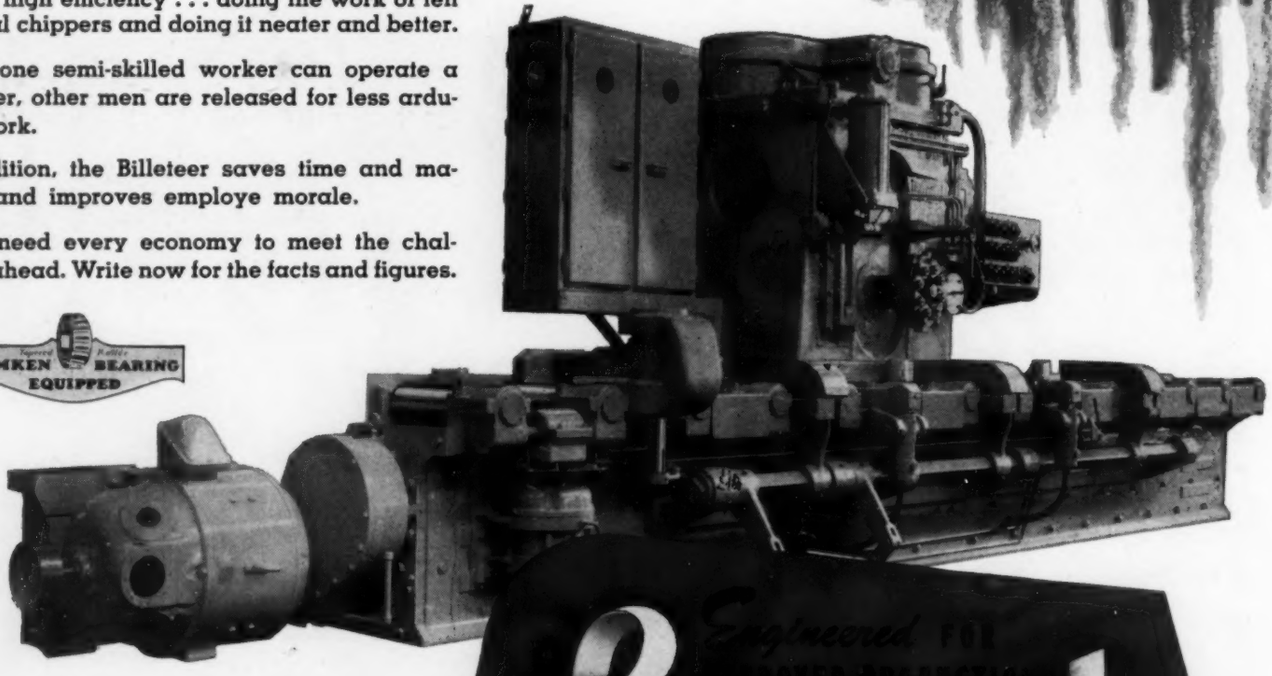
Human muscles and nerves cannot stand the strain of handling a chipping hammer or heavy scarfing torch hour after hour. Fatigue sets in, followed by grogginess and jitters. Despite everything, workers must slow down. Production suffers . . . costs go up.

Bonnot Billeteer-equipped billet-sheds are free from this bugbear of human fatigue. This modern machine never tires . . . works through one shift after another at sustained high efficiency . . . doing the work of ten manual chippers and doing it neater and better.

Since one semi-skilled worker can operate a Billeteer, other men are released for less arduous work.

In addition, the Billeteer saves time and material and improves employe morale.

You'll need every economy to meet the challenge ahead. Write now for the facts and figures.



Send for information

on other Bonnot machines engineered and manufactured to solve specific problems of the iron and steel industries.

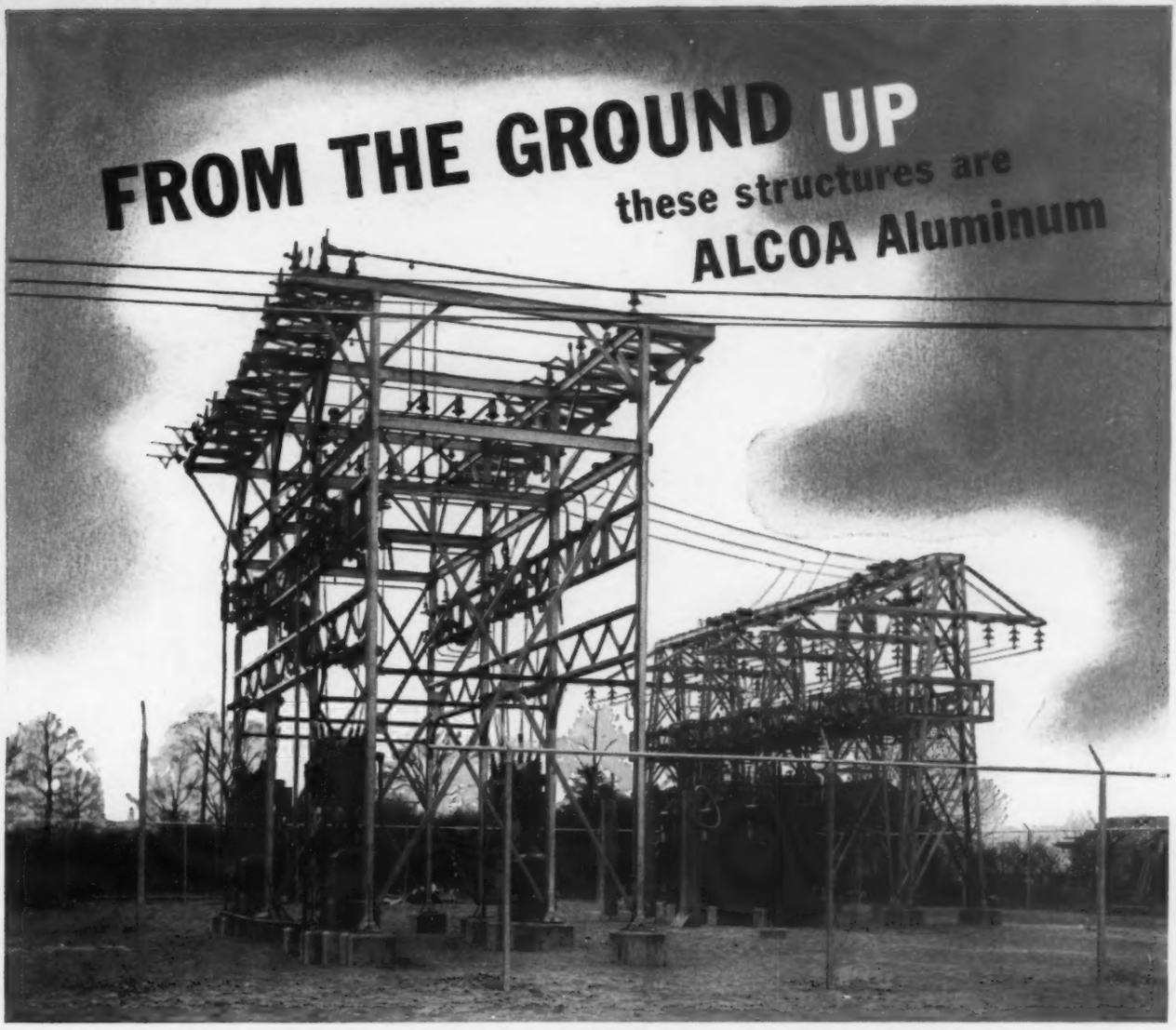
BILLET INSPECTION TABLES
CHARGING TABLES • COLD SAWS
GRINDING PANS • CLAY MIXERS
CLAY FEEDERS, ETC.

Engineered for

Bonnot

BUILDERS OF **THE BILLETEER**

ADDRESS
CORRESPONDENCE TO STEEL EQUIPMENT DIVISION



4kv. and 11kv. Powell Avenue substations of the Pennsylvania Electric Company at Erie, Pa. Fabricated by: Railway & Industrial Engineering Company of Greensburg, Pa.

All parts of these structures are nonrusting Alcoa Aluminum. Painting is eliminated, cutting maintenance costs, reducing service interruptions, decreasing hazards.

Lightweight assemblies permit more shop fabrication—less field work—save erection time and costs.

Standard Alcoa Aluminum shapes, plate, bolts and rivets—lightweight, strong, highly resistant to corrosion, readily available—make it possible for you to obtain these advantages in your structures.

For design data and prices, call the nearby Alcoa office. Or write ALUMINUM COMPANY OF AMERICA, 2128 Gulf Building, Pittsburgh 19, Pa.

ALCOA FIRST IN ALUMINUM

ALCOA ALUMINUM

DETROIT PUBLIC LIBRARY

Cutaway view of the 21.500" O. D. 4-row tapered roller bearing used on the working rolls of a 3-high mill. Radial capacity at 100 rpm is 550,000 pounds; thrust capacity 168-000 pounds.

CHROME NICKEL STEEL

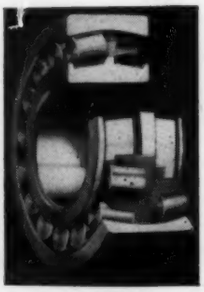
FOR ALL-OUT ROLL NECK BEARING PERFORMANCE

Helping rolling mills achieve peak tonnages is the year-round job of Torrington four-row tapered roller bearings on roll necks. Built of S.A.E.-E3310 steel (with higher nickel content) for maximum tonnage and service life, these sturdy Torrington Bearings efficiently minimize friction . . . handle maximum loads with minimum maintenance requirements...are easily lubricated and serviced.

That's typical Torrington Bearing performance. And it's why you find Torrington Bearings of many types and sizes widely used in the steel industry... on back-up rolls and work-rolls... screw downs, vertical edger rolls, table rolls, sheet levelers and shears...in drives and pinion stands...on many other machines where they carry heavy loads at low maintenance cost.

The engineers of Torrington's Bantam Bearings Division specialize in meeting heavy-duty, high-speed, anti-friction requirements, routine or unusual. Their advice and co-operation is at your disposal.

THE TORRINGTON SELF-ALIGNING SPHERICAL ROLLER BEARING



features self-alignment, two-directional thrust and unit construction for easy installation and handling. It will be manufactured in a complete range of sizes from 1.5748" bore and up. See your nearest Torrington Representative or write for further information.

THE TORRINGTON COMPANY • BANTAM BEARINGS DIVISION
SOUTH BEND 21, INDIANA

TORRINGTON BEARINGS

SPHERICAL ROLLER • STRAIGHT ROLLER • TAPERED ROLLER • NEEDLE • BALL

USE

MORGAN WORCESTER

Ingenuity

Since 1892 when Victor Edwards invented the Flying Shear and made continuous rolling practical, Morgan engineers have pioneered in rolling mill developments. Escapement and Carry over Cooling Beds, Twist Guides, Continuous Heating Furnaces are only a few "firsts" we might mention.

Many others—developed to meet some special situation—are in daily operation but were never published by us.

Can we help with *your* problem?

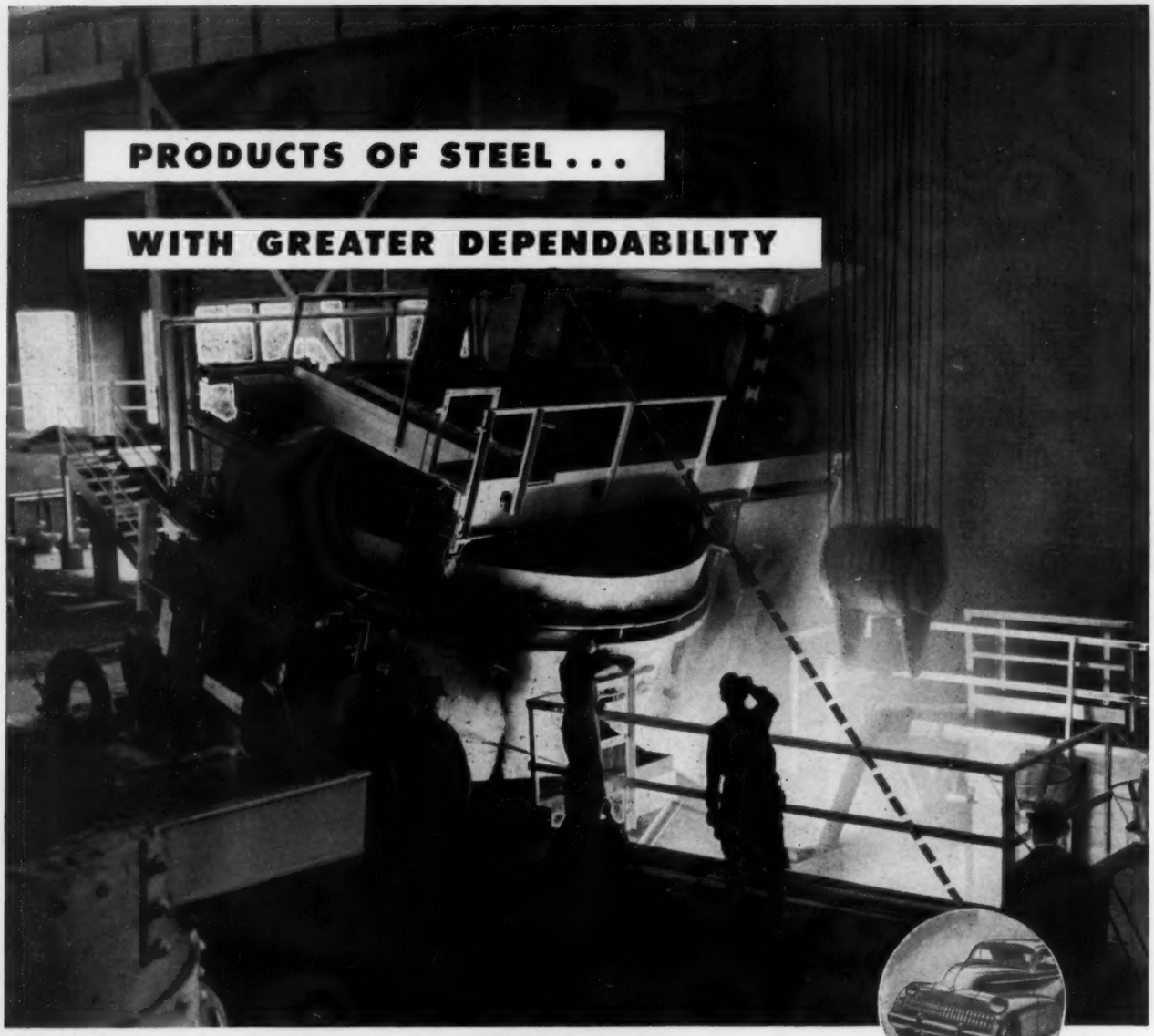
MORGAN CONSTRUCTION COMPANY

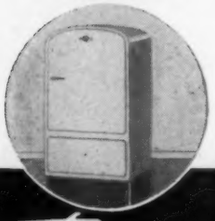
WORCESTER, MASSACHUSETTS

Rolling Mills - Wire Machines
Gas Producer Machines - Regenerative Furnace Control

English Representative: International Construction Co.
56 Kingsway, London, W.C. 2, England

RM 4





SWINDELL

Electric Arc MELTING FURNACES

From initial melting to end-use of your steel, Swindell "Controlled Accuracy" Furnaces assure that dependability so important in meeting today's exacting production schedules.

SWINDELL-DRESSLER *Corporation*

Designers and Builders of Modern Industrial Furnaces

PITTSBURGH, PENNA.

UNITED

HEAVY DUTY ROLL LATHES

Headstock Faceplate Directly Driven by "Cone Worm" Gears

Advantages

1. **Operation at a Steady, Uniform Speed—"CHATTERLESS"**
2. **Cone Worm Drive Permits Compact Construction**
3. **Low Head Room—Facilitates Entry of Roll**
4. **Motors Protected by Headstock**
5. **Cone Worm Drive Rated Conservatively**

The "Cone" type of worm gearing used in UNITED HEAVY-DUTY ROLL LATHES, with its hour-glass shape of worm partially "wrapping" the gear and thus bringing more teeth in constant contact, provides maximum capacity in the smallest space, and chatterless operation. This superiority has been definitely established by test and experience in UNITED 4-high mill screwdown applications.

Low head room facilitates crane handling of rolls, and compact construction permits more floor space and visibility between lathes.

All gearing up to the main cone worm faceplate drive is either single or double helical, is fully roller bearing mounted and carefully proportioned with reference to both velocity and load requirements. These fully enclosed gears and bearings are lubricated by forced oil circulation.

UNITED HEAVY-DUTY ROLL LATHES can be furnished for either "fixed" or "rotating" center.

Consult UNITED engineers for full technical data.

The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment

Showing Comparative Size Between Conventional and "Cone Worm" Headstock

UNITED ENGINEERING AND FOUNDRY COMPANY

Pittsburgh, Pennsylvania

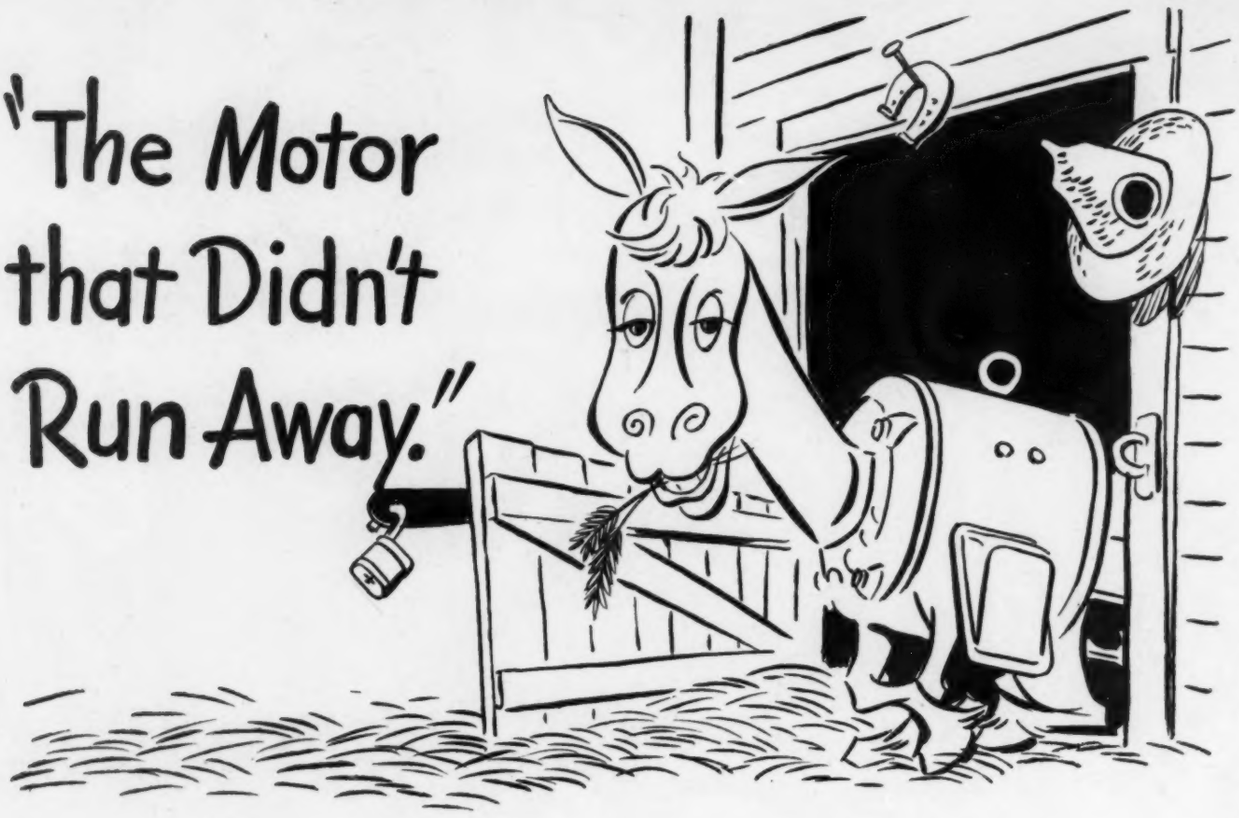
Plants at Pittsburgh · Vandergrift · New Castle · Youngstown · Canton

Subsidiary: Adamson United Company, Akron, Ohio

Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England

Dominion Engineering Works., Ltd., Montreal, P. Q. Canada

"The Motor that Didn't Run Away."



"WHAT do you think would happen if I removed the field on this shunt-wound motor?" the exhibit manager asked the group of engineers.

"It would run away, of course," volunteered a spectator, "or else it would flash over."

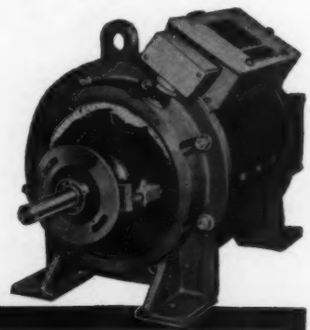
The demonstrator smiled, and threw the switch to cut off the field. The engineers gripped their chairs, momentarily expecting the motor to tear itself violently apart. But no. It just came to a nice, gentle stop!

"You see," explained the Allis-Chalmers exhibit manager, "this motor is controlled by a 'Regulex' exciter in a variable voltage system. And with 'Regulex' on the job, a motor can be kept perfectly under control at all times!"

MORAL: "Regulex" control, through its sensitive mastery of motors and generators, makes possible extremely accurate, rapid adjustments in torque, tension, speed, current.

Thus it steps up production, protects machines, saves time and money. Because it's simple and rugged, it is ideal for use on main mill drives, hoists, tinning lines, and in countless other steel industry applications. Probably there's a job for "Regulex" control in *your* plant.

For the full story on "Regulex" control, see our nearby office, or write ALLIS-CHALMERS, MILWAUKEE 1, WISCONSIN. A 2025



ALLIS AC CHALMERS **REGULEX CONTROL** *"The Educated Generator"*

Alliance 20 ton crane designed and built by The Alliance Machine Co.

New Alliance Floor Type Ingot Charging Machine - - - one of the world's largest

● This Ingot Charging Machine shows that The Alliance Machine Company is still living up to its slogan—"The World's Largest Builders of the World's Largest Cranes." We have built into this machine features that have been developed and tested in the course of our 42 years of engineering and shop experience, and it is little wonder that when steel mill engineers are confronted with unusual problems, involving the handling of the smallest ingot to the 300 ton ladle of molten steel, that Alliance is consulted.

This machine is designed to grip, lift and swing a 20 ton ingot at a radius of 28 feet. The rigid cast steel upper revolving frame turns on conical rollers supported on a one piece cast steel lower frame so designed that the conical rollers operate in a bath of oil.

Great stability had to be provided in this Charger to successfully handle the heavy cantilever loads. This accounts for the ponderous sizes and 400,000 pounds of weight. Both the trolley and bridge are equipped with 8 rolled steel track wheels housed in cast steel compensating trucks. This construction provides smooth operation and reduces the wheel loading to a minimum.

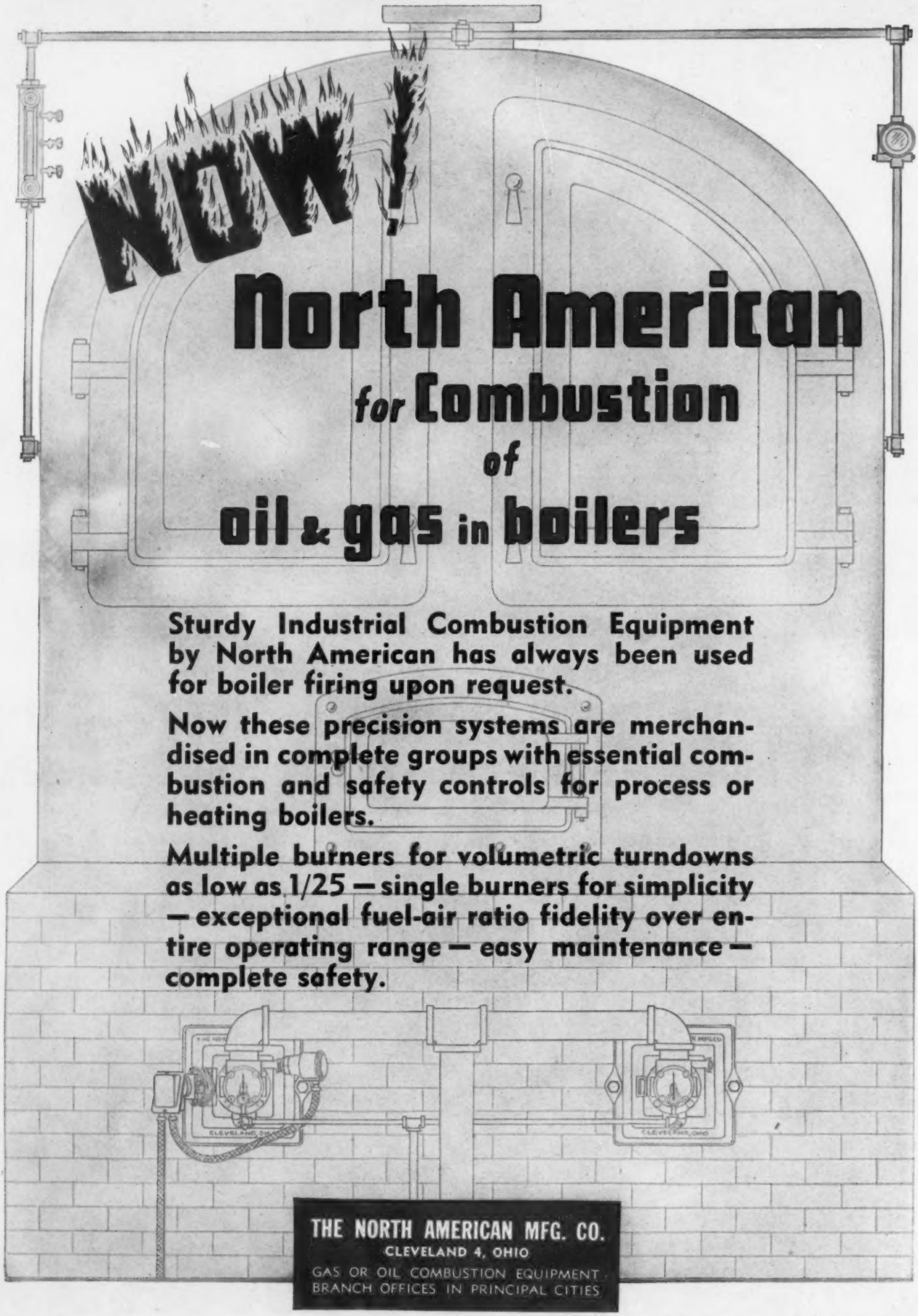
An oil hydraulic system supplies the power for the hoisting and gripping cylinders. Contact rails located in a trench, under the bridge, supplies the necessary operating electric current.

LADLE CRANES . FOUNDRY CRANES . FORGING MANIPULATORS
HOOKING PIT CRANES . STRIPPER CRANES . SLAB AND BILLET
PUSHERS (MECHANICAL) . OPEN HEARTH CHARGING MACHINES

ARMY NAVY

Alliance

THE ALLIANCE MACHINE CO., ALLIANCE, OHIO - Pittsburgh Office: 1622 Oliver Building



NOW!

North American
for Combustion of oil & gas in boilers

Sturdy Industrial Combustion Equipment by North American has always been used for boiler firing upon request.

Now these precision systems are merchandised in complete groups with essential combustion and safety controls for process or heating boilers.

Multiple burners for volumetric turndowns as low as 1/25 — single burners for simplicity — exceptional fuel-air ratio fidelity over entire operating range — easy maintenance — complete safety.

THE NORTH AMERICAN MFG. CO.
CLEVELAND 4, OHIO
GAS OR OIL COMBUSTION EQUIPMENT
BRANCH OFFICES IN PRINCIPAL CITIES

High Speed 5-stand tandem cold mills

UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at PITTSBURGH · VANDERGRIFT · NEW CASTLE · YOUNGSTOWN · CANTON

Subsidiary: Adamson United Company, Akron, Ohio
Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P. Q. Canada

★The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment

FOR PRODUCTION OF SHEET AND TINPLATE STOCK

UNITED ENGINEERING and FOUNDRY COMPANY, for 40 years leader in the development of cold reduction processes, offers immediately available designs for high speed, high production, 5-stand tandem tinplate mills with finishing speeds up to 5000 F.P.M. Also available are designs for modern 4-stand and 3-stand units.

These mills embody all the latest features in auxiliary equipment including uncoilers, guides, coolant systems, tension rolls, coilers, etc.

Consult UNITED'S engineers when making plans for reconversion and expansion.

THE CASE OF THE MISSING

Blast Furnace

Where is it?

Shut down for tuyere and bosh plate replacement.

Keep your stacks going full blast, especially today when every ton counts—hold shutdowns to a minimum—with heat-defying N-B-M Blast Furnace Copper Castings. Our new alloying and pouring techniques assure maximum life for your most troublesome burn-out points.

N•B•M

BRONZE AND COPPER CASTINGS

Blast Furnace Copper Castings • Roll Neck Bearings • Slippers • Housing Nuts • Machinery Castings • Babbitt Metals • Acid Resisting Castings Phosphorized Copper

N·B·M

NATIONAL BEARING

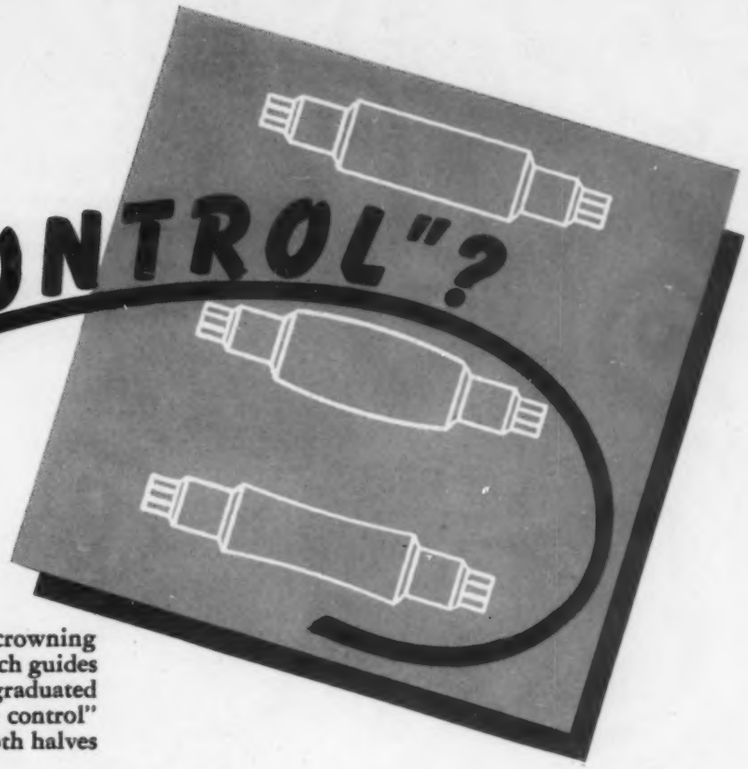
DIVISION

PITTSBURGH • NEW YORK

AMERICAN Brake Shoe COMPANY

PLANTS IN: ST. LOUIS, MO. • PITTSBURGH, PA. • MEADVILLE, PA. • JERSEY CITY, N. J. • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

What gives a Farrel Roll Grinder "CURVE CONTROL"?



Farrel Roll Grinders have an automatic crowning and concaving device, a built-in "brain" which guides the grinding wheel along a perfectly graduated mathematically accurate curve. The "curve control" produces crowned or concaved rolls with both halves perfectly symmetrical.

This patented device is the adjustable, single eccentric type, designed for ease and simplicity of setting. It assures exact synchronism between wheel carriage and wheel, and the same setting invariably produces exactly the same curvature, permitting uniform and easily controlled accuracy of contour in all rolls.

Other features which promote maximum accuracy, speed and efficiency in Farrel Roll Grinders, when grinding either straight or curved rolls, include:

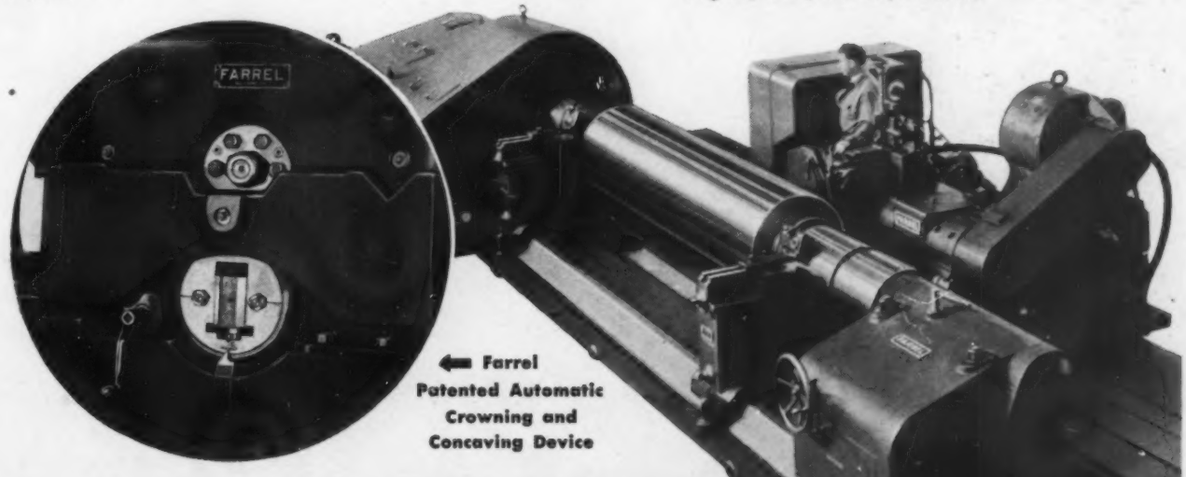
Automatic lubrication of all vital moving parts . . . long-wearing inverted V carriage ways . . . smooth headstock drive by adjustable speed motor through multiple V belts . . . smooth, vibrationless carriage traverse . . . centralized control of entire grinding operation.

Farrel Roll Grinders are available in two types—Type HD with traveling wheel and stationary work, and Type TT with traveling work and stationary wheel. You can get complete details by writing for descriptive bulletins.

FARREL-BIRMINGHAM COMPANY, INC.

ANSONIA, CONN.

Plants: Ansonia, Derby and Stonington, Conn., Buffalo, N.Y.
Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Los Angeles, Tulsa, Houston, Charlotte



⟸ Farrel Patented Automatic Crowning and Concaving Device

FB-328

Farrel-Birmingham

★ Flexibility... program control... quality tonnage, all essentials to war effort, highlight the features of this most modern of soaking pit installations.

Not only is it large in the number of pits, but each pit ranks in individual size—2,800 cubic feet. Electric steel ingots ranging in size from 10,000 lbs. to 34,000 lbs. each are being uniformly heated in minimum time. The total installed capacity is approximately 2,000 tons.

Each of the 24 Surface Combustion Soaking Pits is equipped with automatic temperature and combustion controls. This "Program Control" feature is used to maintain the high quality of the electric alloy steel.

Surface Combustion One-Way Fired Pits offer these outstanding advantages: Simplest Construction; Greater Capacity; Most Efficient Firing; Best Heat Distribution, and Lowest Maintenance. These features have been responsible for the established trend to Surface Combustion Pits during defense and war production years. Since 1936, 145 Surface Combustion One-Way Fired Pits have been installed in leading steel mills... 2/3 of which were installed during the past three years—*when quality tonnage really counted.*

The Heater's and Heat Treater's Helping Hand

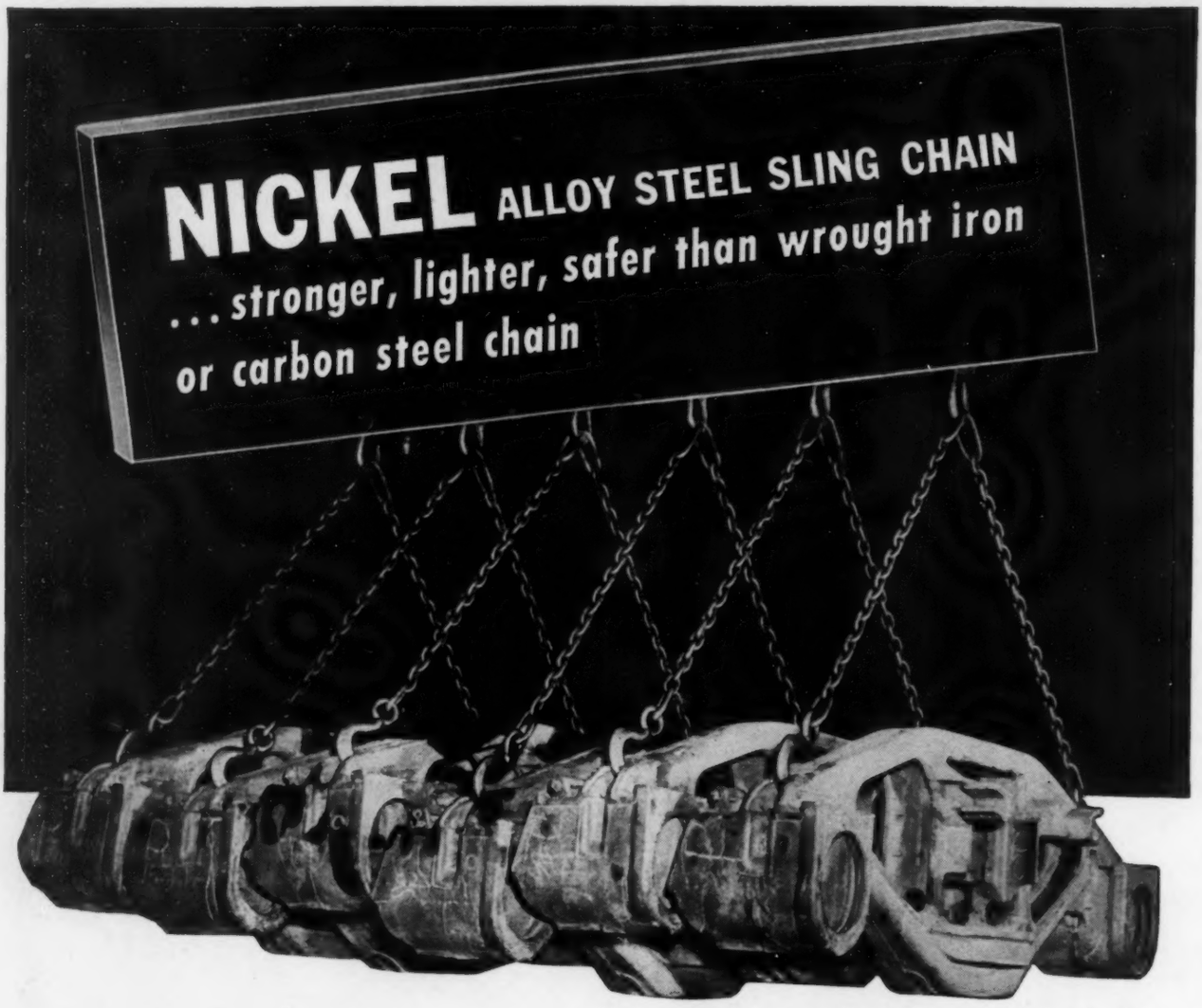
'Surface'

SURFACE COMBUSTION • TOLEDO 1, OHIO

"WHEREVER HEAT IS USED IN INDUSTRY ...FROM INGOT TO FINISHED PRODUCT"

When Quality Tonnage Counts

24 MODERN SURFACE COMBUSTION ONE-WAY FIRED PITS INSTALLED IN THE WORLD'S LARGEST ELECTRIC ALLOY STEEL PLANT



Nickel alloy steel sling chain manufactured by the Columbus-McKinnon Chain Corp. of Tonawanda, N. Y.

The high strength-weight ratio of the heat treated Nickel alloy steel permits a reduction of over 50% in weight, yet results in a stronger, safer chain; lighter and easier to handle in the shop.

And with these advantages come others that mean hard cash savings and greater safety.

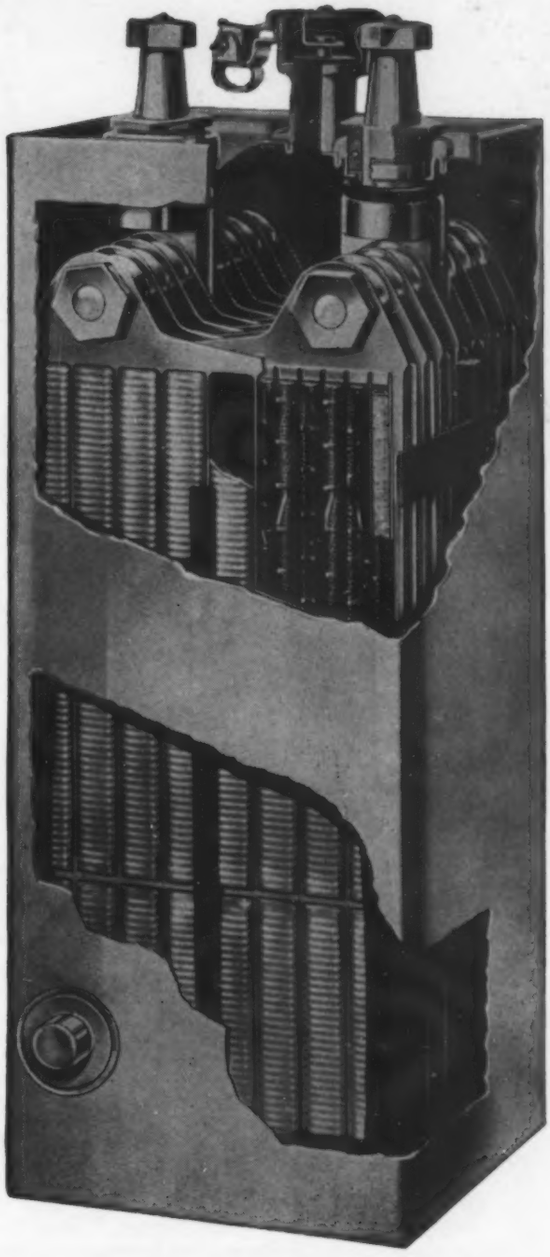
- **It is highly resistant to impact—to the suddenly applied loads which are unavoidable in service.**
- **Its ductility is such that it will s-t-r-e-t-c-h—*not break suddenly*, when overloaded.**
- **Maintenance is negligible . . . no periodic corrective annealing is necessary.**
- **Its higher hardness means greater resistance to abrasion.**

No wonder that more and more users are turning to these lighter and safer Nickel alloy steel chains.

We invite inquiries in the uses and selection of Nickel alloy steels. Counsel and data on request.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street New York 5, N.Y.

BATTERY TRUCKS... give most trouble-free service...



...ALKALINE BATTERIES have the most durable construction

ALL KINDS of material handling operations are being performed by battery industrial trucks with a remarkable record of day-in-and-day-out dependability, freedom from trouble and overall efficiency. In factories, warehouses, railroad shops and docks . . . wherever materials must be moved . . . they are staying on the job with an amazing regularity that surpasses even the highest expectations of users.

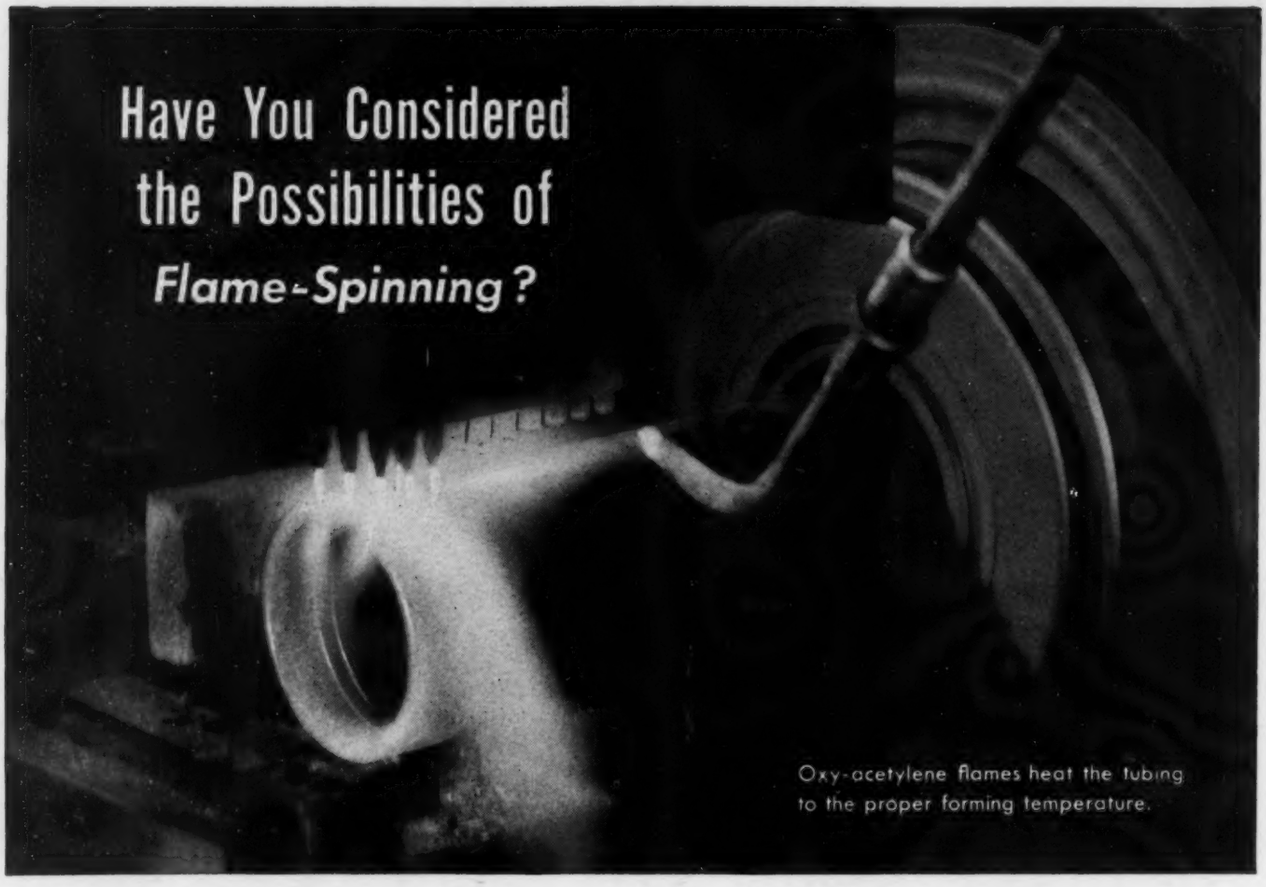
An important reason for their high availability for service is their comparatively simple operating mechanism. The electric drives in a battery truck have the minimum of moving parts to require attention and replacements, and are free from wear-and-tear vibration. Thus a battery truck is rarely out of service for repairs. Exchange batteries keep the truck continuously supplied with power. So except for the few minutes to change batteries two or three times per 24-hour period, the truck need not stop working for servicing its power unit. It is also economical to operate. Not only does it use power most efficiently but the current used for battery charging is the lowest-cost power available. The truck starts instantly, accelerates rapidly yet consumes no power during stops.

Altogether, the battery truck is a most dependable and economical material handling unit . . . especially when powered by Edison Alkaline Batteries. With steel-cell construction, and a fool-proof electrochemical principle of operation, they are the longest-lived, most durable and most trouble-free of all industrial truck batteries. Edison Storage Battery Division of Thomas A. Edison, Incorporated, West Orange, N. J. In Canada: International Equipment Co., Ltd., Montreal and Toronto.

Edison

ALKALINE BATTERIES

Have You Considered the Possibilities of *Flame-Spinning?*



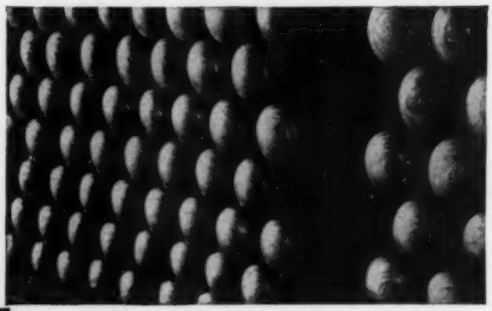
Oxy-acetylene flames heat the tubing to the proper forming temperature.

IT is a fast, inexpensive way to form tubular parts. Flame-spinning will partially close the ends of tubing . . . or make complete closures . . . or reduce diameters at any point. There is no limit to the diameter of tubing that may be flame-spun, provided the ratio of tube diameter to wall thickness does not exceed 50 to 1.

In the pictures, tubing 3 inches in diameter, made from 12-gage sheet, is being end-formed for use in chemical converters. It takes only 45 seconds to close each tube completely.

Ask a Linde representative to show you how you can use the flame-spinning process . . . or write for a copy of the folder, "Flame-Spinning Process," Form 5915.

The flames are withdrawn to allow the forming tool to shape the tube end.



The completely closed tubes are ready for installation in chemical converters.

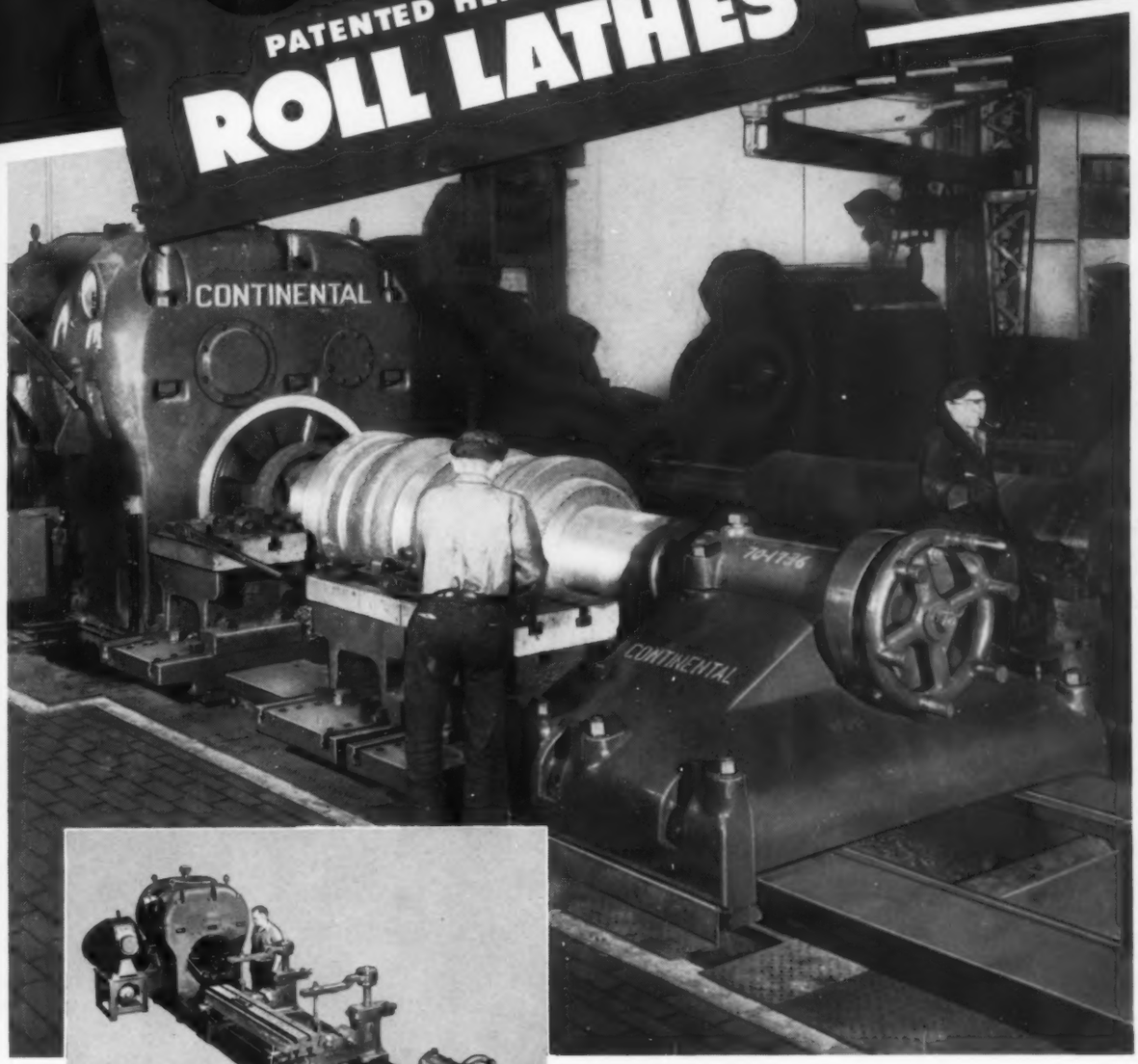
THE LINDE AIR PRODUCTS COMPANY

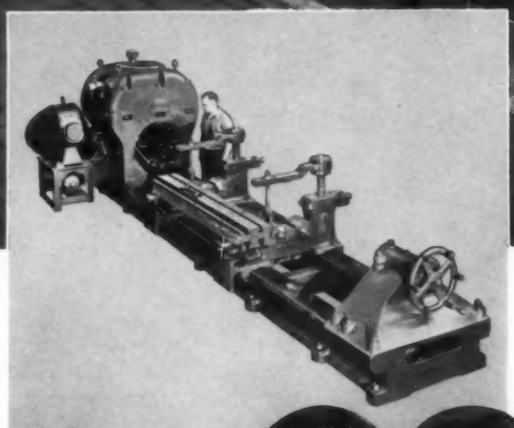
Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

CHATTER
Eliminated in the
Continental
PATENTED HEAVY DUTY
ROLL LATHES





CONTINENTAL Heavy Duty Roll Lathes are now serving leading steel and non-ferrous plants in United States and abroad.

Continental

Elimination of Chatter in the patented CONTINENTAL Roll Lathe permits the speedy turning of rolls to a high degree of accuracy and smoothness of surface. Built-in ruggedness also makes it ideal for heavy cuts when roughing is required.

Let CONTINENTAL engineers show you how this advanced-engineered, modern roll lathe will meet your most exacting requirements!

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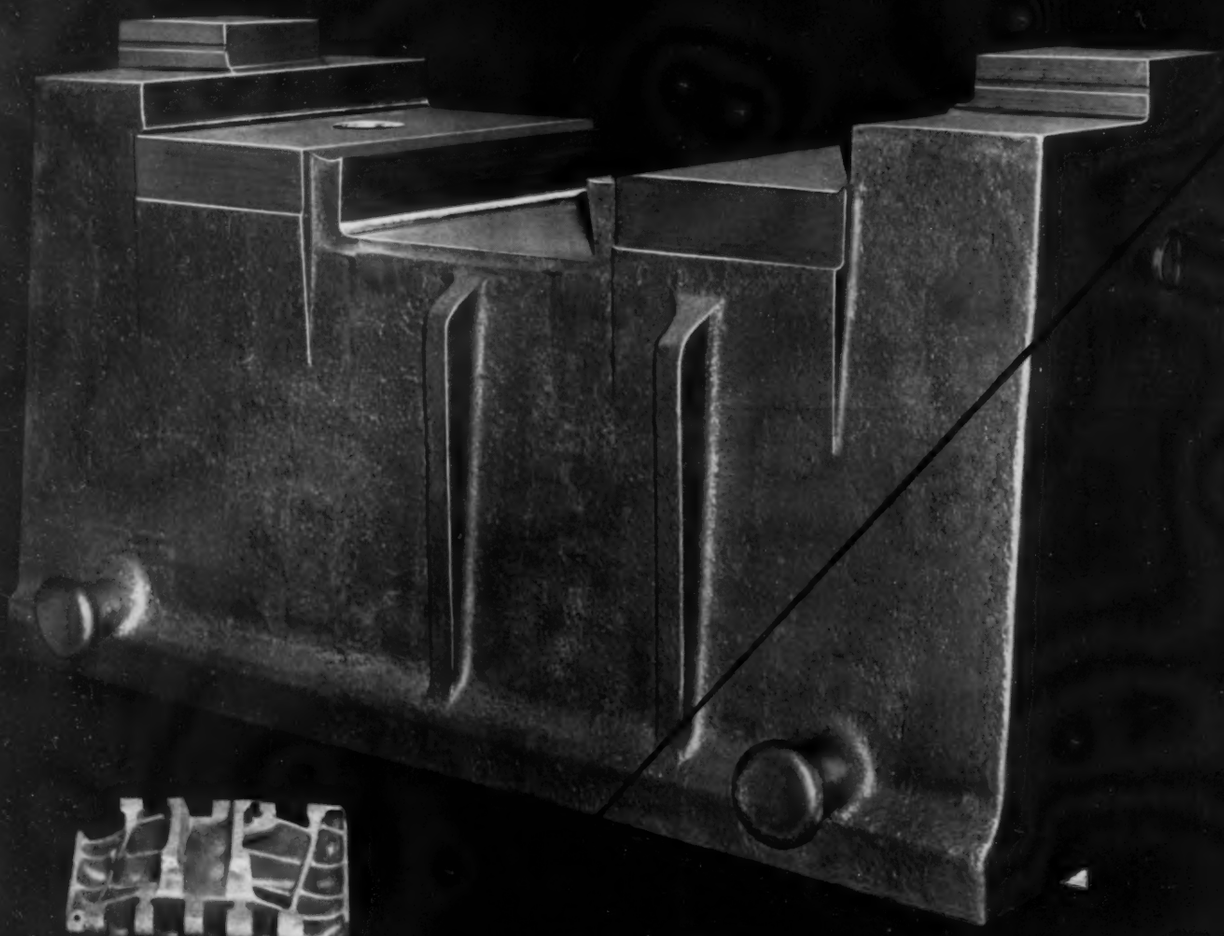
PITTSBURGH · CHICAGO
Plants at E. Chicago, Ind., Wheeling, W. Va., Pittsburgh, Pa.

at

50 pound or 250,000 pound



. . . are all in a day's work!

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Around a PENNSYLVANIA TRANSFORMER *in 60 seconds*

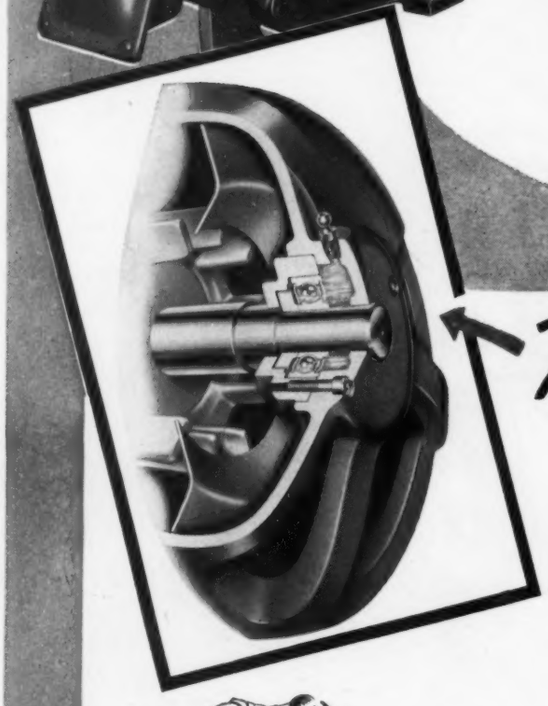
• Yes, we timed it—one minute to read the copy in this ad! We don't presume that you can learn everything about a transformer in 60 seconds. We do maintain, however, that much can be learned from the exterior appearance of a transformer—and in a very short time. The construction of the cooling tubes, the lift lugs, the accessories used, the welding,—all are evident—all invite your inspection. They indicate the high quality Engineering and Manufacturing technique that we are proud to point out in every Pennsylvania Transformer.

LIFT LUG FOR UNTANKING CORE, COILS AND COVER AS A UNIT
LUGS FOR LIFTING COMPLETE TRANSFORMER
NON-MAGNETIC PLATE FOR MOUNTING LOW VOLTAGE BUSHINGS
SCREENED BREATHER
TOP FILTER PRESS CONNECTION
Typical 250 through 500 Kva Single Phase Transformer
DIAL-TYPE THERMOMETER
OIL GAUGE
HEAVY GAUGE COOLING TUBES WELDED TO TANK WALL
TAP CHANGER
STRUCTURAL STEEL BASE
SAMPLING VALVE AND FILTER PRESS CONNECTION
DRAIN VALVE

Pennsylvania
TRANSFORMER COMPANY
808 RIDGE AVENUE, N. S., PITTSBURGH, PA.

Pennsylvania TRANSFORMERS

You can't grease 'em wrong!



This Bearing Design

PROTECTS

RELIANCE *Series C* MOTORS

INDEFINITELY!

OVERGREASE . . . UNDERGREASE . . . FAIL TO GREASE

IT MAKES NO DIFFERENCE!

Write today for Bulletin C-118 which gives complete details on the many additional advantages of Reliance Series C Motors.

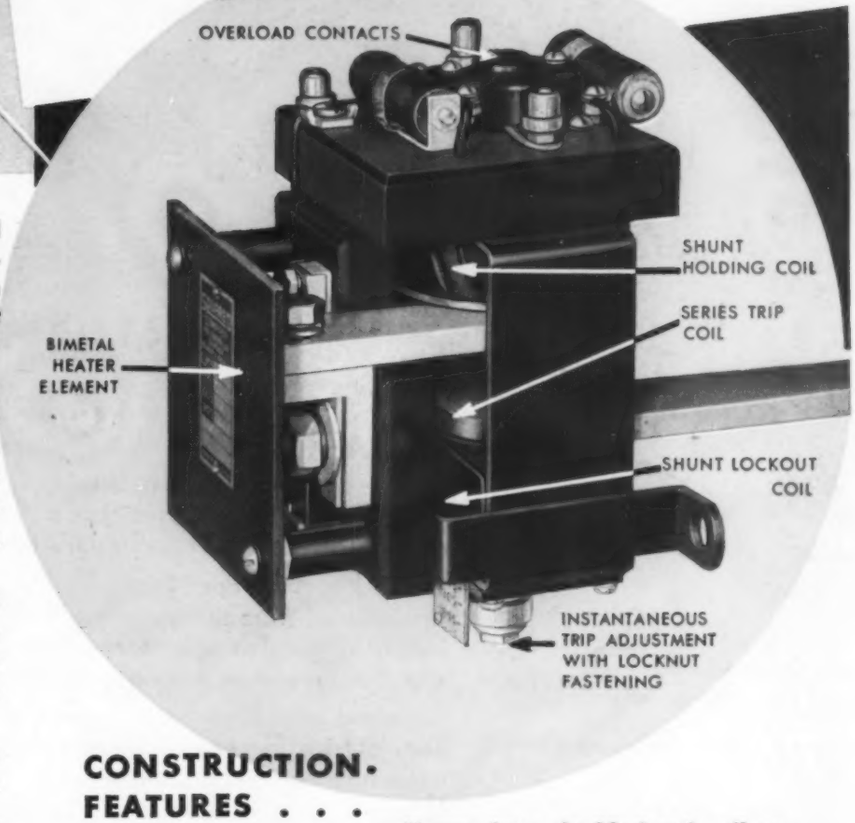
RELIANCE ELECTRIC & ENGINEERING CO.

1084 Ivanhoe Road **Cleveland 10, Ohio**

Birmingham • Boston • Buffalo • Chicago • Cincinnati • Denver • Detroit • Gary • Greenville • Houston • Kalamazoo • Kansas City Knoxville • Los Angeles • Milwaukee • Minneapolis • New Orleans • New York • Philadelphia • Pittsburgh • Portland, Ore. • Rockford, Ill. St. Louis • San Francisco • Seattle • Syracuse • Tampa • Tulsa • Washington, D. C.

RELIANCE A·C D·C MOTORS

Now... DUAL PURPOSE OVERLOAD RELAY for HEAVY DUTY D.C. MILL CONTROL



COMBINES inverse time thermal *overload* protection with instantaneous *over-torque* protection in a *single device.* This is how it operates—

Load current flows through series trip coil and heater element. Shunt lock-out coil prevents operation of instantaneous trip plunger until current corresponding to desired torque limit is reached.

Sustained moderate overloads open the control circuit through operation of the bimetal heater element which is selected to match the motor rating.

The shunt holding coil can be connected to provide either automatic reset or remote hand reset.

Write

for information on CLASS 7950 SERIES Heavy Duty D.C. Control for cranes and mill auxiliaries and CLASS 9003 Master Switches. Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin.

CONSTRUCTION-FEATURES . . .

Heavy-duty, double-break, silver contacts with protective cover. • Visual indication of instantaneous trip setting calibrated 200 to 500% of rated current. • Non-carbonizing, slate insulating bases. • Ballast resistors operated at only half capacity. • Single frame size suitable for 100 to 600 amp continuous duty ratings.

SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

P-G Limit Switch *Resistors* . . . . . .

for use with . . .

CRANE HOIST SAFETY LIMIT STOPS!

P-G Limit Switch Resistors are available for use with any crane hoist safety limit switch operating on direct current from 5 HP to 200 HP.

Design of the P-G Resistance Grid is ideal for safety limit stop operation because it produces a resistor element of sufficient mechanical strength to withstand the brief but heavy overloads peculiar to this service.

Constructed from the same basic parts used for P-G Standard Unit Resistors, long trouble-free service is assured without worry over vibration, moisture or corrosive fumes.

Standard enclosures as illustrated give ample protection from ordinary outside mechanical damage with no sacrifice of ventilation so necessary for dissipation of heat.

Try a P-G Limit Switch Resistor on your next application, particularly, if service conditions are severe.

Detailed information in BULLETIN No. 500

Copy on request

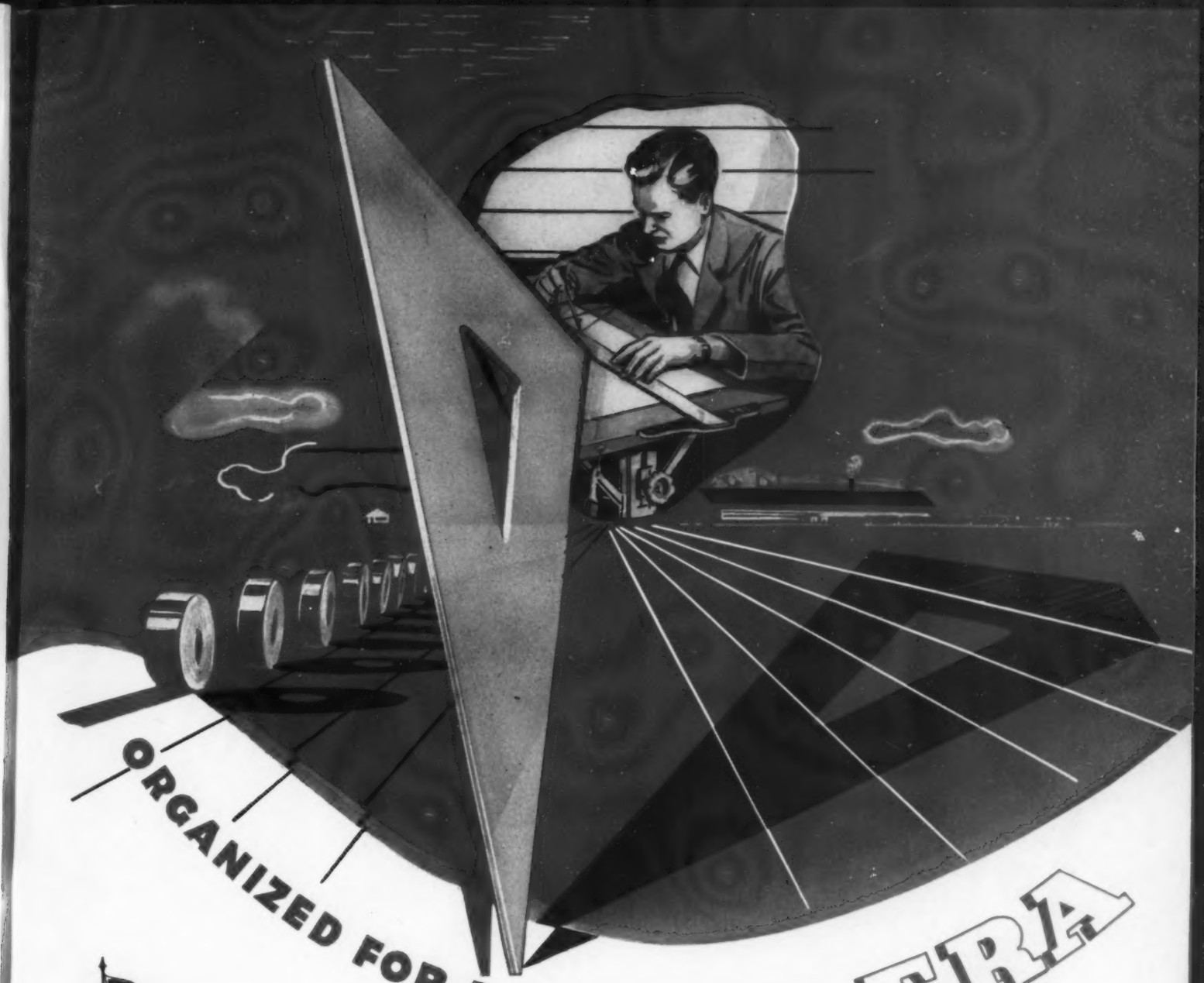
P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO



ORGANIZED FOR A NEW ERA

The ability which won the Army-Navy "E" and four stars is now available to American industry.

Tomorrow's metals will be rolled and processed on modern equipment. From the minds of aggressive engineers will come the plans for future mill machinery . . . their knowledge and past experience will assure efficient operation.

Although young as a corporation, Arms-Franklin was organized for just such a future. Alert and vigorous, intent upon tomorrow's processes, the individuals are rich in experience, each with a successful record of accomplishment. Rolling mills, tables, picklers, sheet and plate levellers, straighteners, slitting lines and other equipment operating in many plants were designed and built by these practical men. Consult them on plans for economical production of tomorrow's rolled metals.

The ARMS-FRANKLIN CORPORATION

YOUNGSTOWN 3, OHIO

Subsidiary Company

TAYLOR-WILSON MFG. CO. : Pittsburgh, Pa.

ENGINEERS AND BUILDERS OF ROLLING MILL MACHINERY

DOES PULSATION PLAY TRICKS IN YOUR PLANT?

HOW TO CUT H.P. LOSSES

Pulsative flow in gas, air and vapor lines doesn't limit its effects to visible or audible vibration in plant buildings and equipment, or to inaccurate orifice meter readings. It also wastes power because compressors must overcome the reflection of the pulsation cycle in addition to keeping the gas stream moving forward.

For example—Tests conducted recently by a Natural Gas Company showed a horsepower loss of 10.3% on the crank end and a loss of 12.4% on the head end of its compressors. After installing FLUOR Pulsation Dampeners on discharge lines, *this power loss was reduced 76% on the crank end and 53% on the head end.* By eliminating pulsative flow and its adverse characteristics, the FLUOR Pulsation Dampener quickly pays for itself through the saving it effects in power cost. Only 24 hours were required to make this installation.

The FLUOR Pulsation Dampener has no moving parts. It operates with beneficial effects on friction losses, horsepower savings and rate of flow. If vibration plays *tricks* in *your* plant, it may be due to pulsative flow in air, gas or vapor lines. In that case, the FLUOR Pulsation Dampener is your answer.

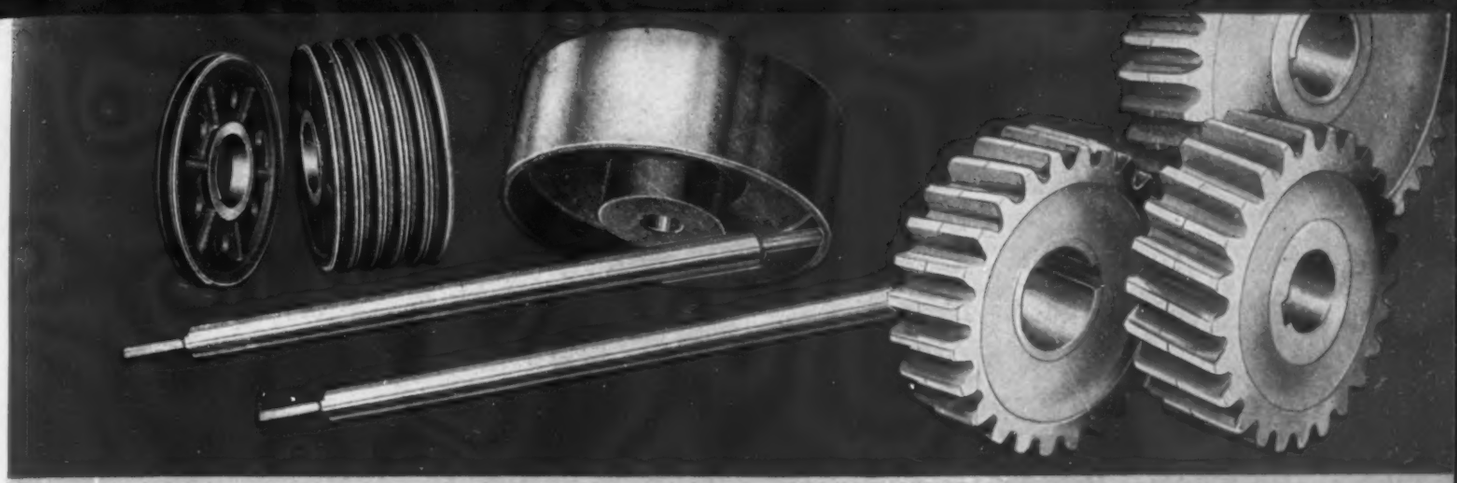
BE SURE WITH FLUOR SINCE 1890

FLUOR PULSATION DAMPENER

THE FLUOR CORPORATION, LTD. 2500 South Atlantic Boulevard, Los Angeles 22

NEW YORK • PITTSBURGH • KANSAS CITY • HOUSTON • TULSA • BOSTON

ENGINEERS • MANUFACTURERS • CONSTRUCTORS



"TOOL STEEL" PROCESS

SPECIALLY HARDENED STEEL PRODUCTS

"TOOL STEEL" PROCESS

GEARS • PINIONS • SCREWDOWN SCREWS AND NUTS
BRAKE, CRANE AND SHEAVE WHEELS • ROLLS
SPROCKETS • MILL HERRINGBONE PINIONS

are guaranteed **to reduce your maintenance costs through longer life and more production.**

THE TOOL STEEL GEAR & PINION COMPANY

CINCINNATI, OHIO

ELECTRIC BRAZING FURNACES PROVED BY 40 YEARS

Every G-E Furnace Brings You These "Plus-dividends" of Leadership—

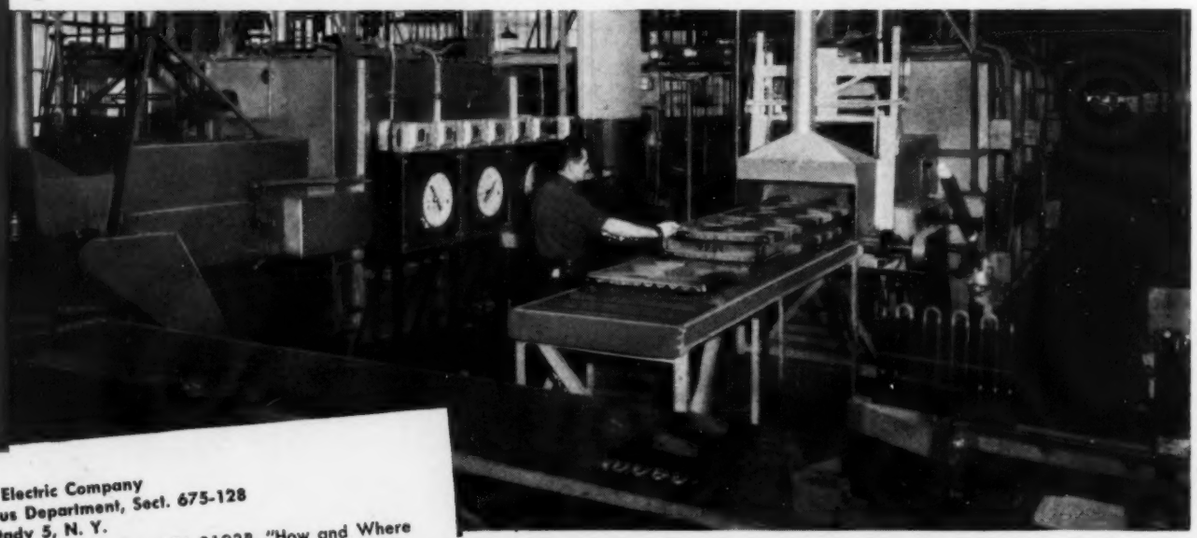
★ **Performance-proved Construction**
★ **Technical Assistance**
★ **Nationwide Field Service**

Pioneer and leader in electric furnace brazing since 1906, General Electric is well prepared to fulfill your furnace needs with performance-proved equipments—with designs steadily improved by forty years of experience, research, and development. G-E "know-how" is available to assist in product and process improvements by suggesting proper techniques, both before and after you buy your brazing furnace. And an expert field engineering organization is maintained in major cities throughout the country to speed installations, help solve operating problems, and to be readily available for servicing of equipment.

Better Products by Brazing—Electric furnace brazing merits consideration as both a cost reducer and as a likely means of *improving your product.* Here are some of the reasons:

1. Manufacturing costs may be substantially reduced by substituting the fabrication of inexpensive subassemblies (stampings, screw-machine parts, tubing) for forgings, machining, and castings.
2. The great strength of furnace-brazed joints often means increased life of subassemblies and therefore reduced service costs.
3. Gas tight joints are made possible to an unusually high degree.
4. Bright surfaces and smooth fillets (without subsequent cleaning operations) mean excellent appearance.

Furthermore, furnace brazing permits savings in time, material, weight, and space. It is adaptable to both high and low production rates, and its flexibility permits a variety of assemblies to be handled with a single equipment.



Roller-hearth furnaces, for high-quantity production, operate continuously months on end at 2050 F without shutdowns for repairs—thanks to well-supported, heavy ribbon-type heating units; large-diameter, low-stressed alloy rolls; and other conservatively designed features. Here, steel-fin refrigerator condensers, each with brazing metal (copper) preplaced at 800 joints, are brazed in a single trip through the controlled-atmosphere heating and cooling chambers of these furnaces.

General Electric Company
Apparatus Department, Sect. 675-128
Schenectady 5, N. Y.

Please send me bulletin GEA-3193B, "How and Where to Use Electric Furnace Brazing," and also the following (please check): ☐GEA-4066, Box Furnaces; ☐GEA-4071, Mesh-belt Conveyor Furnaces; ☐GEA-4072, Roller-hearth Furnaces.

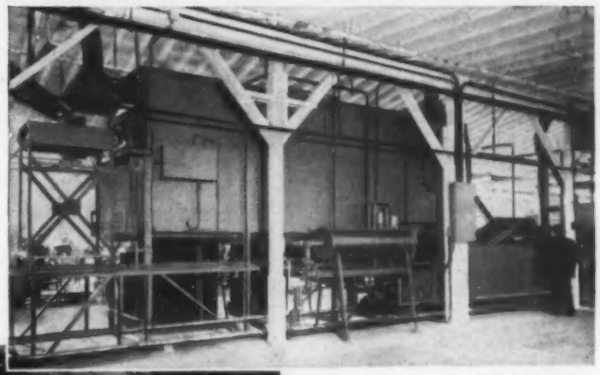
Name.....
Company.....
Address.....
City.....State.....
8128

FOR PRECISION HEAT-TREATING AT

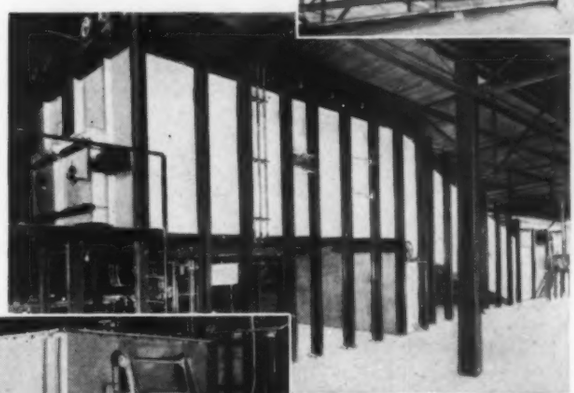
...AND IMPROVED
FURNACE BRAZING EXPERIENCE

You reap the benefits of G-E "know-how" on these heating equipments, too . . .

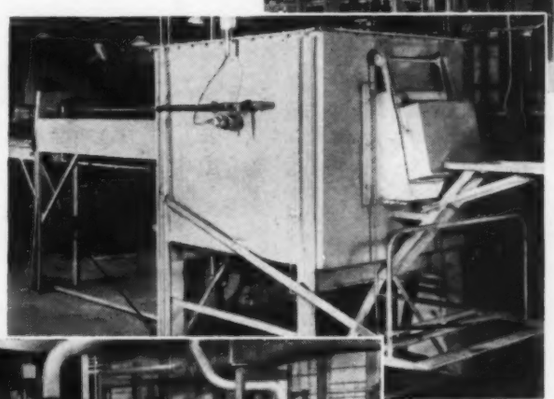
In addition to brazing furnaces, G.E. builds electric furnaces for virtually every type of heat-treating process. Here are just a few:



▲ **Belt-conveyor hardening furnace**—for uniform, automatic, *clean* hardening, without decarburization, of bolts, bearing races, business machine parts, and many similar products.



Porcelain-enameling furnace—This continuous-type conveyor furnace produces a durable, high-lustre finish in porcelain enameling of cast-iron and sheet-steel stove and range parts, kitchenware, signs, table tops, refrigerator liners and cabinets. ▶



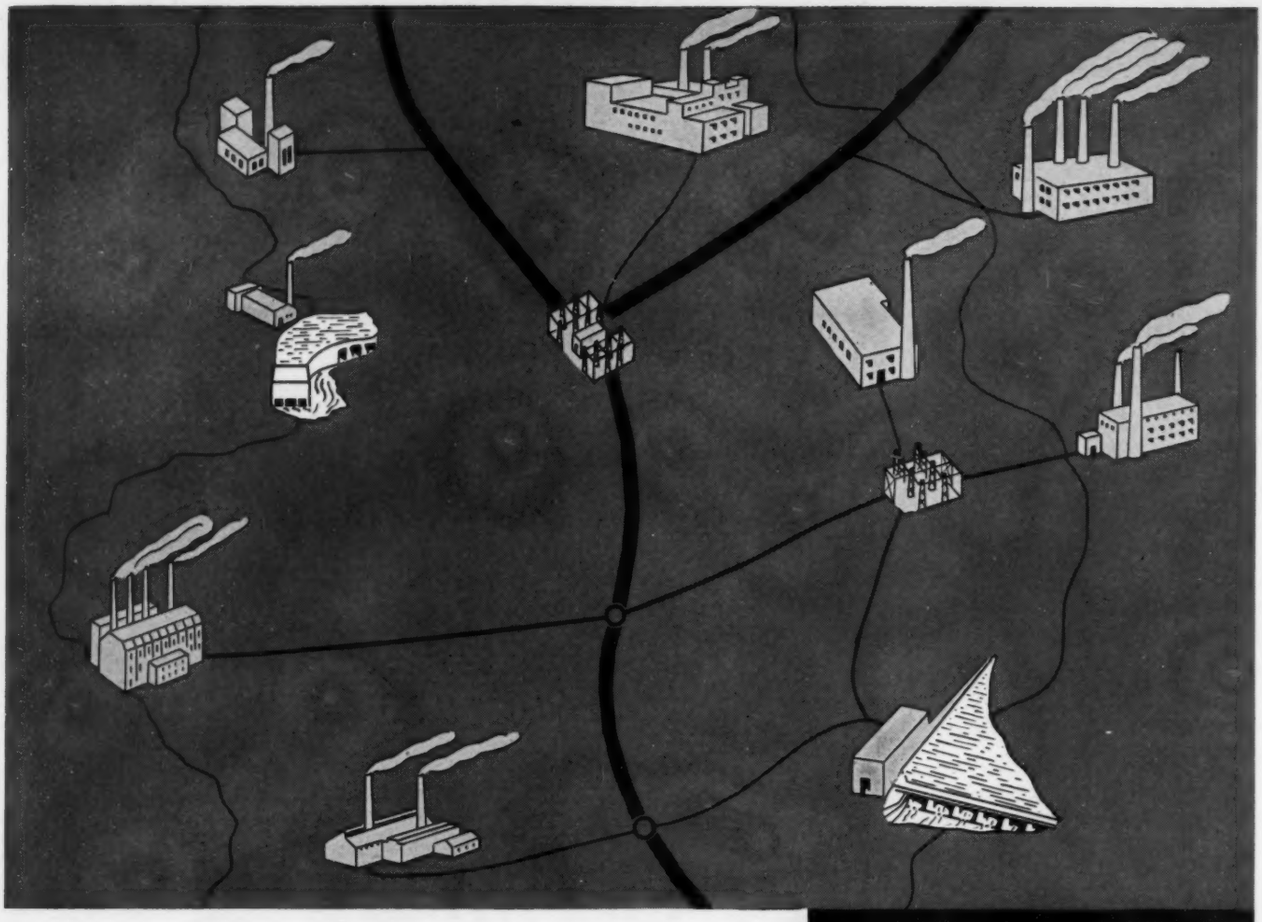
Box furnace—ideal for jobbing shop or small-scale production for furnace-brazing, bright annealing, bright normalizing, scale-free hardening, and sintering powdered-metal compacts. The well-supported heating units may be nickel-chromium ribbon (2100 F max. operating temperature), silicon carbide (2500 F max.), or moly rod (2750 F max.). ◀

Mesh-belt conveyor furnace—A flexible, continuous-type equipment for high-quality brazing, bright-annealing, bright normalizing, and sintering. Heating *and cooling* take place within the protective atmosphere to assure clean, bright work.

General Electric has also had wide experience in the development and construction of electronic induction and dielectric heaters for a variety of applications, in addition to furnaces and small heating devices. Our heating specialists and application engineers are prepared to recommend the electric heating equipment most suitable for your process.

GENERAL ELECTRIC

LOWEST OVER-ALL COST . . . *USE ELECTRIC FURNACES*



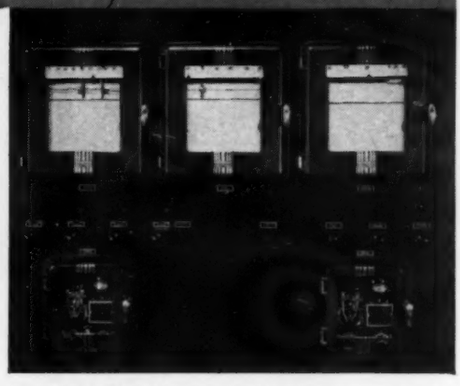
IS YOUR MILL IN A POWER NETWORK?

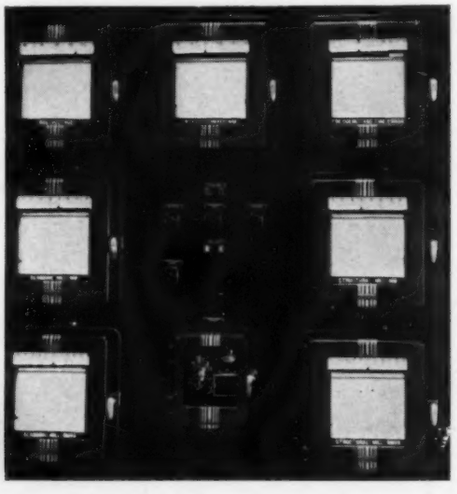
The economy which a load dispatcher customarily maintains — and which is his regular responsibility — can be increased very substantially by giving him two automatic "tools" for his work.

One tool is a Micromax Load Recorder or Recorders to show load conditions promptly and continuously. The other tool is L&N Automatic Load-Frequency Control, to carry out the dispatcher's orders.

A fraction of one per cent of the total investment in a big industrial power plant will provide this equipment. The installation is even more advisable when one recalls the total of this investment.

This is just one reason why power systems which total more than 35,000,000 kw capacity now use these L&N instruments. If you'd like to consider joining this total, an L&N engineer will be glad to sit down with you and explain, or to send Technical Publication N-56-161(1), as you may prefer.





L&N Load Recording and Load-Frequency Controlling Panels. Above — for a Public Utility; below — for a steel mill.

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

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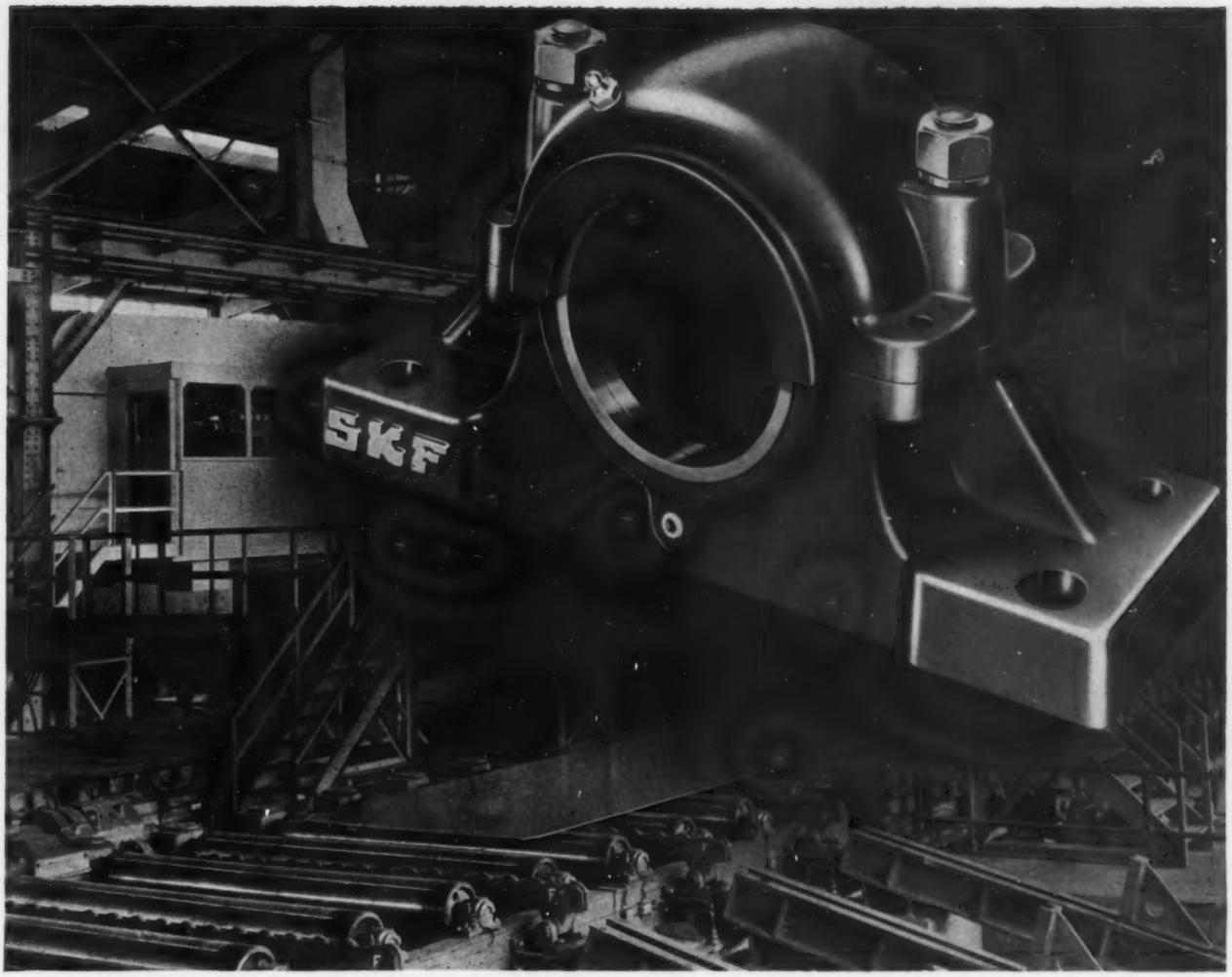


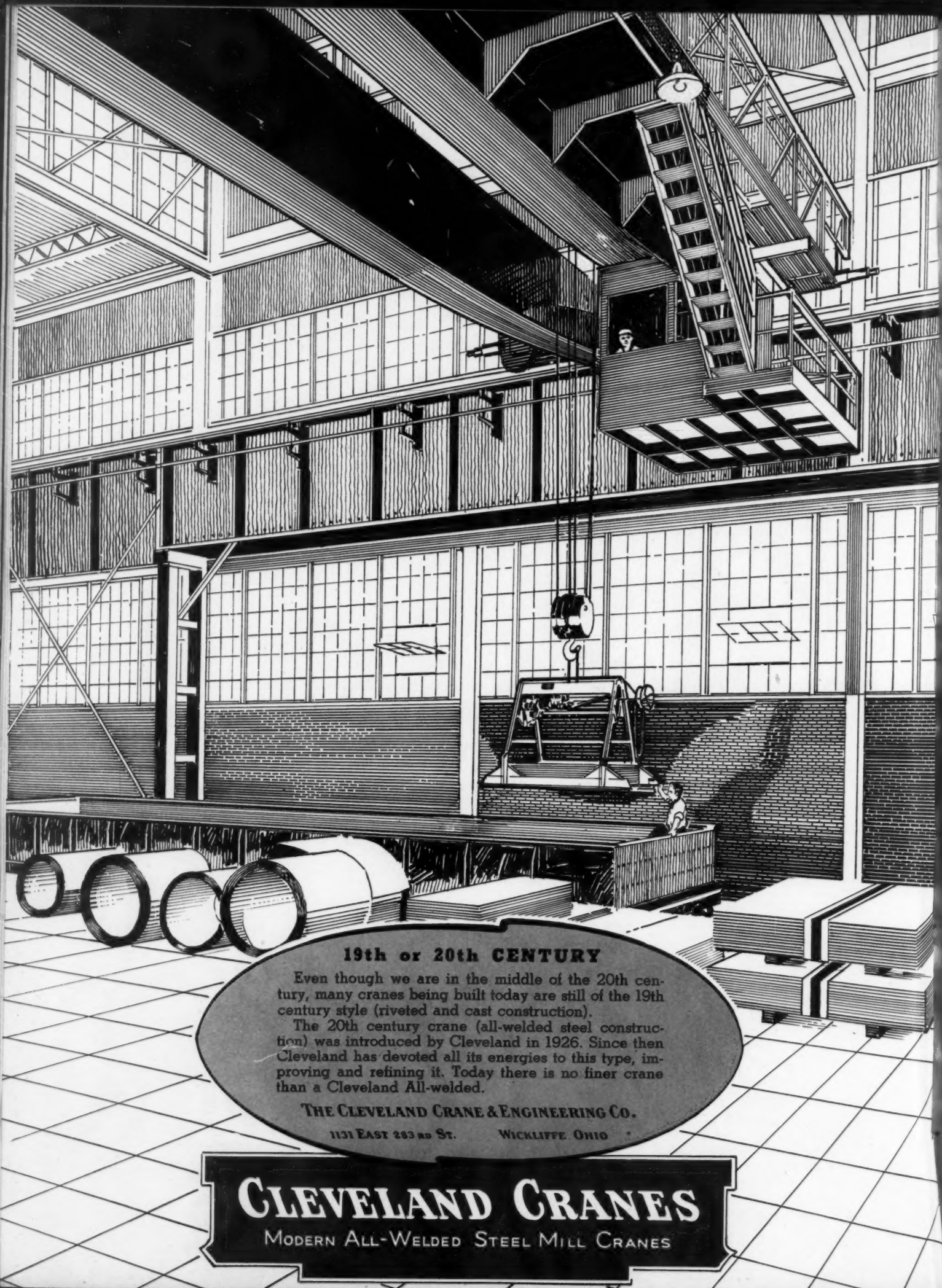
TABLE ROLLERS ON 120" MILL, AT LUKENS STEEL CO., BUILT BY UNITED ENG'G & FOUNDRY CO.

Rolling 'em IN THE RIGHT PILLOW BLOCKS

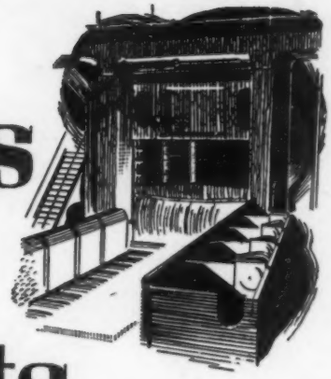
When they roll inside SKF Table Roller Pillow Blocks, SKF Spherical Roller Bearings roll smoothly and continuously, ignoring dust, scale, water, etc. That's because these husky, two-piece pillow blocks, cast in either iron or steel, are equipped with SKF's exclusive non-rubbing labyrinth Triple Seals . . . assure maximum load carrying capacity in a minimum of space. Roll out *your* strip on SKF Bearings that roll in SKF Table Roller Pillow Blocks. 6102

SKF
BALL AND ROLLER
BEARINGS

SKF INDUSTRIES, INC., PHILA., PA.


19th or 20th CENTURY
Even though we are in the middle of the 20th century, many cranes being built today are still of the 19th century style (riveted and cast construction).
The 20th century crane (all-welded steel construction) was introduced by Cleveland in 1926. Since then Cleveland has devoted all its energies to this type, improving and refining it. Today there is no finer crane than a Cleveland All-welded.
THE CLEVELAND CRANE & ENGINEERING CO.
1131 EAST 283 RD ST. WICKLIFFE, OHIO
CLEVELAND CRANES
MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts



HAVING received the blessing of the United States Department of Justice, sale of the Geneva steel plant in Utah to the United States Steel Corporation finally becomes official. The sale was first approved by the Price Review Board of War Assets Administration after receiving strong support from western interests, including the Western States Council which represents 100 chambers of commerce in 11 western states. This Council's analysis of other bids brought out various shortcomings, including lack of operating organizations, requirements for additional government investment or loans, lower actual cash offers, etc. A vital factor in influencing the Council's recommendation was the steel corporation's statement that products sold to the public would be priced on a Geneva basing point.

In spite of the addition of the Geneva capacity, United States Steel Corporation now totals only 32.7 per cent of our national capacity, as compared to 35.3 per cent before the war.

▲

CAUSES for the shrinkage of United States Steel Corporation capacity are the scrapping of some obsolete, inefficient units and the sale of plants to other producers. Sales of Carnegie-Illinois' Farrell works to Sharon Steel Corporation, and its Mingo works to Wheeling Steel, touched off an interesting series of shifts. As a result of the purchase, Sharon plans to abandon its Lowellville works, which then attracted the interest of a group of non-integrated flat-rolled producers as a source of sheet bar. Wheeling is planning a $50,000,000 expansion at Mingo, and has sold its Portsmouth plant to a new company, Portsmouth Steel Corporation, formed to supply steel to Kaiser-Frazer Corporation and to some of the non-integrated sheet producers. Rumor has also connected the new corporation with a number of other small producers in a possible merger.

▲

ENGINEERS from various foreign countries have, for the past several months, been touring the United States studying methods to step up production in their own countries. One of their important conclusions must undoubtedly be that the elimination of strikes would accomplish the most.

FIRST direct subsidies in the steel industry come from RFC, at the request of CPA, paying Jones and Laughlin Steel Corporation $45.84 per ton for sheet bar and selling it for $38.00 per ton to Apollo Steel Company, Superior Sheet Steel Company, Reeves Steel and Manufacturing Company, Mahoning Valley Steel Company and Parkersburg Steel Company.

▲

JUST as a reminder of the past, steel scrap is again scarce, with the shortage estimated to become worse over coming months. Causes are said to be the industry's increased use of scrap during blast furnace shutdowns occasioned by the coal strike, and the slowdown in scrap return because of reduced metal working operations — again the result of strikes.

▲

IN the New York Herald Tribune appeared the following by Frank Lynn:

By the banks of Potomac a tit in a tree
Sang "Trillo, Petrillo, Petrillo."
And I said "Little birdie, your song used to be
'Titwillow, titwillow, titwillow'."
The tomtit retorted, in tones of disgust,
"E Pluribus Unum, it can't be discussed,
We sing what democracy says that we must —
Petrillo, Petrillo, Petrillo!"

▲

AND if you think you can get away from it all by dying, please note that a report issued by the National Selected Morticians says that the average funeral cost in 1945 was $332.98.

▲

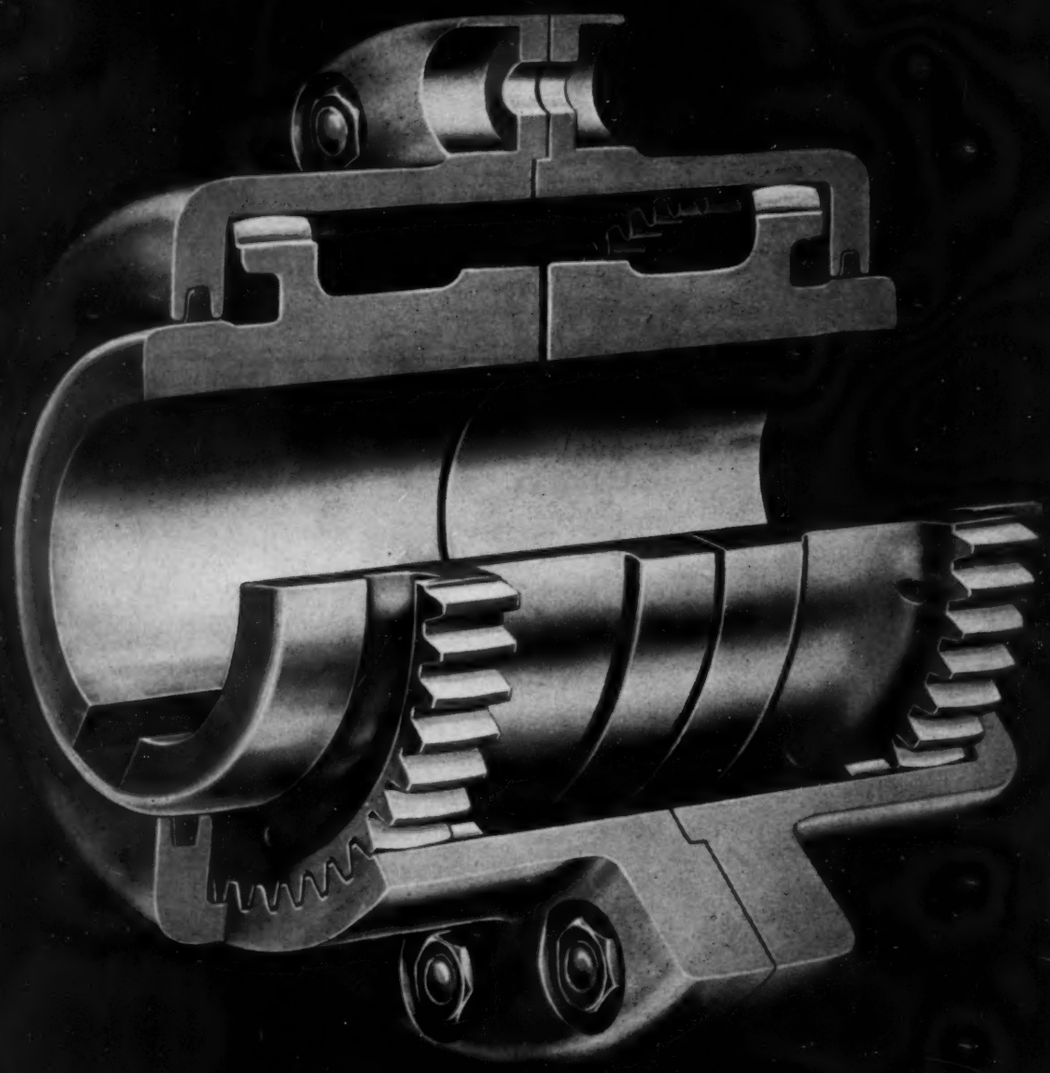
HENRY FORD II has said: "There is no reason why a union contract could not be written and agreed upon with the same efficiency and good temper that marks the negotiation of a commercial contract between two companies." In our thinking, the main difference at present is that, in a commercial contract, both parties are usually responsible.

▲

DIVIDENDS, a house organ of Ketchum, MacLeod and Grove, Inc., summarizes labor publicity as including more than 800 regularly published union newspapers with a combined circulation of 15,000,000, a tabloid with 400,000 circulation, a library of motion picture films, considerable radio time, a direct mail campaign of propaganda to 60,000 men and women who influence public opinion, and a "pamphlet-of-the-month" club. Further plans call for the establishment of a number of radio stations.

Quoting Dividends: "Recent polls of labor opinion show that 40 per cent of the workers are against full production; 27 per cent of the workers think that banks, coal mines, electric utilities and railroads should be nationalized; a large proportion think that industry is to blame for depressions . . . To regain the friendship of its millions of workers, management will have to do an even better job of telling its story to its employees and the public. And it really has a better story because management, not union leaders, provides the jobs and pays the wages."

POOLE



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Empire Building
Pittsburgh, Pennsylvania

Iron AND Steel ENGINEER

JULY, 1946 VOL. XXIII NO. VII

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Warm-Worked Casing -

A NEW OIL COUNTRY PRODUCT

. . . . it is only recently that the very important effect of the proportional limit on the collapsing strength of tube casings has been properly evaluated . . . . warm working provides a means of uniformly raising the proportional limit and thus improving casings . . . .

by J. Jay Dunn

ASSISTANT TO VICE PRESIDENT

NATIONAL TUBE COMPANY

▲ THROUGHOUT the development of the petroleum industry, the casing of deep wells has presented a serious and complicated problem to the maker of pipe used for this purpose. The depth of wells has increased from a few hundred feet to over sixteen thousand and at the present time, depths of eighteen thousand feet are being seriously considered. The average depth of wells drilled in the United States has remained fairly constant over the past twenty years, but the footage drilled beyond five thousand in depth has progressively increased. Thus, the importance of the resistance of pipe used in deep wells to external fluid pressure has been correspondingly emphasized.

Pipe used to case deep wells may be subjected to an unbalanced external fluid pressure, due to a hydrostatic head, equal to the well depth. The specific gravity of the fluid is assumed as not less than 1.153. In some circumstances it may be as high as 1.47. The design of strings of casing, in general, requires at least two pipe sizes; the outside diameter of the coupling on the smaller pipe must clear the inside diameter of the pipe through which it must pass. This imposes a strict limit on the wall thickness. Strength of the hoisting tackle and power of the engine, as well as cost, are further restrictions on dimensions. The economic answer is to be sought mainly in the strength characteristics of the pipe material. Warm worked casing provides an answer to the problems involved.

In the warm working process, the final reduction to size ranging up to some 8 per cent of the diameter is made at a temperature between the blue brittle range and the lower critical temperature. The result is casing with high transverse compression and longitudinal tension properties. The increased transverse compression strength leads to high collapse resistance and the increased longitudinal tension strength to increased joint strength. A wide range of the improved properties is possible by variation of the per cent reduction and temperature. Contrary to expectation the physical properties produced by warm working are greatly increased over those obtained by cold reduction and subsequent aging treatment.

There is much of interest to engineers and, to express it mildly, not a little to be learned from a study of the efforts made over the past forty-odd years to solve this problem of deep well casing. It is proposed to review briefly a few of the published investigations of the problem and to present in outline the work carried out by the research organization of National Tube Com-

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pany in seeking to improve the collapse resistance of deep well casing.

The earliest investigation of the resistance of pipe to external pressure as that problem related to the oil industry was undertaken by Prof. Reid T. Stewart, and was published under the title of, "Collapsing Pressures of Bessemer Steel Lap-Welded Tubes," in Transactions, American Society of Mechanical Engineers, Vol. 27, 1906.

Stewart states that the purpose of his investigation was the "supplying an urgent demand for reliable information on the behavior of modern wrought tubes when subjected to fluid collapsing pressure." The fact that a large proportion of the pipe tested was designed as casing leads one to credit the urgent demand as coming from the oil industry.

The plan and the execution of the test program cannot be improved upon today for the purpose of supplying reliable information on the collapse resistance of casing for the use of the oil industry. The test data related to a definite commercial product class. The test specimens were selected with a close approach to random choice. The report presented sufficient data to permit examination of the conclusions reached.

In evaluating his test results, Stewart limits his conclusions to lengths greater than "about six diameters" and combines all the variables such as characteristics of the steel, out-of-roundness, variation in wall, and others, suspected and unsuspected, in constants for the pipe class. Then the collapsing pressure is expressed as a function of the pipe dimensions.

In this manner Stewart derives two equations:

For pipe having a $\frac{t}{D}$ ratio of 0.023 or greater

$$P = 86{,}670\left(\frac{t}{D}\right) - 1386 \quad \text{.....(B)}$$

For pipe having a $\frac{t}{D}$ ratio less than 0.023

$$P = 50{,}210{,}000\left(\frac{t}{D}\right)^3 \quad \text{.....(G)}$$

The distribution of the test results is stated in per cent departure from the formula values. Thus, "not one of the several hundred tubes tested failed at a pressure lower than 42 per cent of the probable collapsing pressure, while ½ of one per cent of the number of tubes failed at 37 per cent and two per cent at 25 per cent of that pressure." Checking these percentages with the data, it is found that the calculated pressures were for the measured pipe dimensions, and the intention was to say that not one of the several hundred tubes tested failed at a pressure lower than 42 per cent *less* than the probable collapsing pressure.

This method of evaluating the test results is not too questionable if the purpose were to determine the relation of pipe dimensions of a class to the collapse resistance. The statistical average of the test collapsing pressures was 99.1 per cent of the calculated values with a coefficient of variation of 11.11 per cent. For the pipe user, however, the method fails to furnish the needed information. His pipe orders specify a nominal size of a class. It is the nominal and not the actual dimension that should be used with formula developed from the measurements of test specimen. When the formula pressure is calculated on the basis of the nominal dimension's, Stewart's test data (217 tests, figures 34 to 41 inclusive, Stewart's paper) present a statistical average of 98.4 per cent of the calculated values with a coefficient of variation of 18.8 per cent. The effect of this great increase in this coefficient is shown in Table I.

TABLE I

Per cent of the ratio, test pressure to calculated pressure, using nominal pipe dimensions

(Stewart's data, Figures 34 to 41, inclusive)

Ratio less than	Per cent of total
0.75	9.67
0.70	6.45
0.65	3.22
0.60	1.38
0.50	0.46

The lowest ratio was 0.4883 for test No. 243. Stewart's value for this test was 0.83. This is an extreme. Stewart's recommended factor of safety, under the conditions of use as well casing, would give, as a rough estimate, a probable failure of one in three million lengths of pipe. However this may be, his data were used with satisfactory results for many years. It was only when seamless pipe assumed an important position in the casing of deep wells that Stewart's test data required revision.

Shortly after the first world war, seamless pipe became available for well casing. Previously the process had demonstrated its quality for rotary drill pipe. Initially, the product was confined to steel grades A and B, having minimum yield strengths of 30,000 and 35,000 psi. When grade C with 45,000 minimum yield strength was produced, the question of collapse resistance required an answer.

Prof. Stewart, using test data he developed with National Tube Company, revised his formulae on the assumption that collapse resistance was determined by yield strength. Hence, expression (B) was made to apply to seamless pipe by multiplying the expression by the ratio of the average yield strength of the seamless to the average yield strength of the bessemer lap-welded pipe used in his early tests.

The formulae as revised fitted the data about as well as for the lap-welded pipe for the soft grades. For the grade C, the fit was noticeably of wider spread.

The grade C casing 7 in. × 30 lb, which is the advisable heaviest weight for the diameter, had a calculated safe setting depth of 5315 feet. Pipe of this D/t ratio was required at the time for only about five per cent of the total. But well depths were increasing, and the economy of stronger pipe was obvious. To meet the demand, National Tube Company, from their long experience with cold drawn tubing, considered the possibility of producing a high strength pipe for casing by cold sizing the usual hot rolled product. Tests re-

sulted in an unexpected great increase in the collapse pressure, but the pipe shattered to such an extent under the failing pressure that the idea was abandoned. It was not realized that shattering under a collapsing pressure is not a measure of ductility unless consideration is given to the energy stored in the test jacket and to the pipe dimensions. The idea was abandoned the more readily as a desirable increase in collapse resistance was secured by a simple carbon-manganese chemistry in the hot rolled product leading to the API Grade D.

Great interest was created in this question of collapse resistance of pipe by a paper presented by Jasper and Sullivan in 1931. Their paper, "The Collapsing Strength of Steel Tubes," APM-53-17b, Transactions of American Society of Mechanical Engineers, 1931, pp. 219-245, after considering several variations of the rational expression for the collapse of tubes at stresses in the elastic range, proposed calculating the collapse resistance as a function of the ratio of the pipe diameter to the pipe wall. The stress was read from a set of curves relating the pipe dimension to the failing stress at various yield strength levels. These curves are shown in Figure 1. The envelope curve indicated as 1 is calculated from Sturm's equation. A simple and approximately correct form for this equation is

$$P = \frac{C}{(D/t)^3} \quad \ldots\ldots (1)$$

$$C = \frac{2E}{(1-\mu^2)} \quad \ldots\ldots (2)$$

The authors use, to express the relation of collapse pressure to the unit stress

$$P = \frac{2(D/t-1)\sigma}{(D/t)^2} \quad \ldots\ldots (3)$$

For most collapse problems no material error is introduced by replacing (3) with

$$P = \frac{2\sigma}{D/t} \quad \ldots\ldots (4)$$

This substitution results in a simple expression when P is eliminated between (1) and (4), giving

$$\sigma = \frac{C}{2(D/t)^2} \quad \ldots\ldots (5)$$

In these expressions:

D = outside diameter of the pipe
t = wall thickness of the pipe
E = Young's modulus
μ = Poisson's ratio
σ = unit stress at pressure P
P = critical collapsing pressure

These equations apply to pipe not less than eight diameters in length and for dimensions resulting in stresses in the elastic range.

It will be noted that equation 1 is Stewart's equation (G) with C = 50,210,000

The data presented in the paper was for:

256 Lap welded bessemer steel pipe (Stewart's results)
21 Perfect (machined) tubes, Prof. Carman
14 Arc welded pipe
4 Seamless pipe

The four tests on seamless pipe and Stewart's data

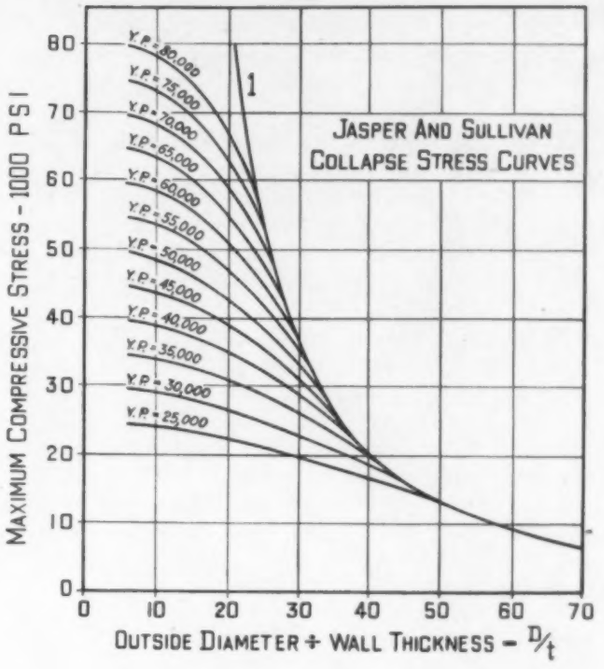


Figure 1 — Collapsing strength of pipe as determined by T. McLean Jasper and John W. W. Sullivan.

are the only tests in which the collapsing pressure stressed the pipe beyond the elastic stress range. Consequently, the data do not permit any check of the curves other than boundary Curve 1. The use of the diameter to wall ratio instead of the reciprocal as used by Stewart has come into general use.

The Jasper and Sullivan paper devotes extensive space to considering the effect of out-of-roundness and variation in wall thickness on the resistance to a collapsing pressure. Data from 199 of Stewart's tests was used to compare the stress calculated from the collapsing pressure and pipe dimensions with the stress for perfect tubes. The difference between these two figures expressed as a percentage of the perfect tube is assigned as the effect of out-of-roundness. The authors stated they were forced to assume that the effect of wall variation was relatively unimportant, alleging the data were not sufficiently complete to permit separation of the two effects. A more precise statement is that the data indicated a wide range in the combinations of wall variation and out-of-roundness.

The stresses for the perfect tube were determined by reading the stress from a curve for the average yield strength of Stewart's pipe material, which was 37,000 psi, similar to the yield strength curves of Figure 1.

Their analysis resulted in depicting the effect of the combination of ovality and variation in wall thickness as a straight line relation between the D/t ratio and the percentage reduction in the collapsing stress for several degrees of ovality. Two of those equations will picture

the serious effect thus attributed to ovality on the collapse resistance.

For ½ per cent ovality, the per cent reduction = 0.4 D/t

For 2 per cent ovality, the per cent reduction = 0.8 D/t

Ovality is defined as the difference between the largest and smallest diameter expressed as a percentage of the average.

In his discussion of the Jasper and Sullivan paper, Prof. Stewart stated that his own attempt to evaluate the effect of out-of-roundness was abandoned, as it was found that the axis of the oval of one section was at an angle of widely varying magnitude with the axis at a closely adjacent section, with the one thus acting to support the other.

In his paper Stewart stated that "the slight out-of-roundness of the tubes tested was the chief factor in determining the place of collapse." Since Jasper and Sullivan found a very important effect of ovality in Stewart's data, they have been carefully checked by the author and reproduced in Figure 2. The figure bears out Stewart's statement. The careful wording led to an examination of the test data for a comparison with the test results of the entire series. Table II presents the important items of the comparison.

The examination of Stewart's data relating to the effect of ovality uncovered two tests which had an extreme difference in test collapse pressure when the formula pressures, as well as other related details, were closely the same. As an illustration of the puzzle that remained unsolved for many years, the data are reproduced in Table III.

The data presented by Jasper and Sullivan cannot be used to investigate the stress curves in the plastic range for Figure 1, but are sufficient to check, at least approximately, the elastic stress curve 1 of that figure. The comparison of the three sets of data are shown in Table IV on the basis of the value C of formula (2).

In the discussion of the Jasper and Sullivan paper, R. G. Sturm credited the authors with having pointed out that "there are two distinct limitations upon the strength of thin shells under external pressure. One is that of purely elastic instability and the other is that of instability resulting from plastic yielding of the material of which the shell is made." Continuing, he said, "Between these two cases lies the range which cannot be figured by formulas for either case." Jasper and Sullivan, in their closure, said they "have not been able to adjust themselves" to the term plastic yield. "It is believed that at or below the appropriate curves shown for a steel of definite physical properties and with definite dimensions of a tube, no plastic action is possible in the material."

It is not easy to comprehend why neither the Jasper and Sullivan paper nor the discussions made any reference to the earlier work of Engesser, von Karman, Westergaard, and others, showing that the theory of elastic buckling of a straight bar can be extended to cover the case of plastic buckling.

Their paper has not been credited with its value as an incentive to renewed effort to solve the unexplained range of collapse test results. The paper posed the problem by inferring that if the pipe were true to form and dimensions, the curves of Figure 1 would check test results within a range too narrow to be worth mentioning.

Following the presentation of the Jasper and Sullivan paper, the published record is a blank for several years. The research division of National Tube Company was

TABLE II

Comparison of the ratio, test pressure to formula pressure, for pipe failing with the axis of collapse on the smallest diameter with the like ratio for all tabulated tests

	Average ratio	Coefficient variation per cent	Range
29 Specimens failing with axis on the smallest diameter	1.0287	6.4	0.9047 to 1.1464
188 Specimens of the tabulated data	0.9903	11.1	0.5750 to 1.247

TABLE III

Unexplained test results

	Test 244	Test 255
Test collapse pressure	1750 psi	790 psi
Formula (B) pressure	1403 psi	1375 psi
Ratio test to calculated	1.247	0.575
D/t ratio	31.08	31.85
Yield strength	41710 psi	42920 psi
Ovality	1.337 per cent	1.000 per cent
Wall variation	13.43 per cent	10.06 per cent

TABLE IV

Value determined from test data presented in appendix 3 of the Jasper and Sullivan paper

$$C = \frac{2E}{(1-\mu^2)} = P\,(D/t)^3 \qquad \text{.....(6)}$$

	C average	C range	Coefficient of variation, per cent
Stewart's tests, 28 pipe	50.77×10^6	$(42.66 \text{ to } 58.28) 10^6$	8.10
Carman's tests, 21 pipe	65.61×10^6	$(47.02 \text{ to } 75.44) 10^6$	11.73
Author's tests, 14 pipe	67.96×10^6	$(56.64 \text{ to } 79.84) 10^6$	9.61

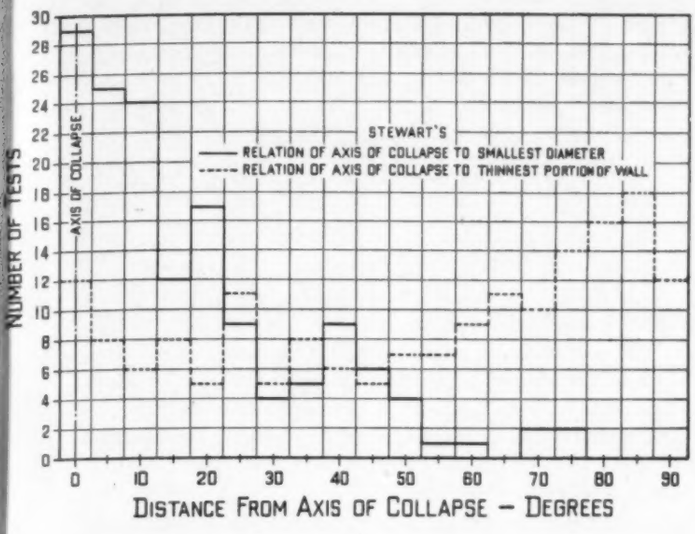
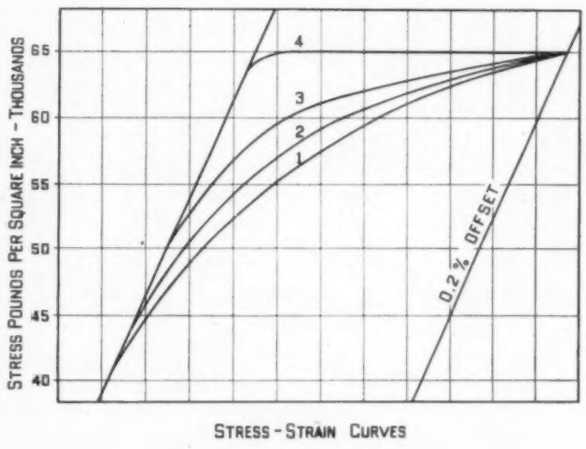

NUMBER OF TESTS
AXIS OF COLLAPSE
STEWART'S
RELATION OF AXIS OF COLLAPSE TO SMALLEST DIAMETER
RELATION OF AXIS OF COLLAPSE TO THINNEST PORTION OF WALL
DISTANCE FROM AXIS OF COLLAPSE – DEGREES

Figure 2 — This chart illustrates that the axes of collapse is apt to be on the smaller diameter and ninety degrees from the thinnest portion of the wall.

▲

Figure 3 — The graphs show that even for the same material, the stress-strain curves can vary widely.



occupied in an endeavor to find a better fit to collapse test data on seamless pipe than Stewart's SS formula. The pipe tested, when of the same nominal dimensions, varied in the measured D/t ratio. It was necessary to eliminate this variation in order to correctly evaluate test results. A great deal of time was spent developing a technique for producing accurate stress-strain curves. The requirement set was that the data should plot a smooth curve to an elongation scale of 1:1000 and a stress scale of 1:10,000. We were convinced by this work that collapse resistance was closely related to the stress-strain characteristics.

A method for using the stress-strain curves was to calculate the expected collapse pressure by using the stress as measured on the curve, in Birnie's formula, the stress being at the point where the total strain was

$$e=\frac{0.943\ (D/t-1)}{(D/t^3)} \qquad (7)$$

Tests made in groups of four were expected to have test collapse pressures within the range of 83 to 107 per cent of the calculated pressure. It was realized that there was no logical basis for the use of the total strain, but its use gave better results than any other method that had been tried.

A wide variation was found among the stress-strain curves of what was assumed to be identical material. This difference is illustrated in Figure 3. In the figure, four curves selected from a large number are adjusted to a common yield strength as a means for showing the variation in type.

During 1935 one manufacturer introduced their high yield casing. The collapse resistance of this product was based on the stress curves of the Jasper and Sullivan paper of 1931. The transverse compression yield strength was specified as 80,000 psi minimum for D/t ratios less than 25. This yield strength was obtained by cold work. The minimum tensiles of the material prior to forming the pipe were:

Minimum tensile strength . . . . . 80,000 psi
Minimum yield strength . . . . . 50,000 psi

The tabulated collapsing pressure for 7 in. × 0.332 in. × 24 lb casing is 5810 psi. By the Lamé formula the stress is 64,260 psi. The stress read from the curve is 64,400 psi, plus or minus the reading error. The SS formula pressure for 80,000 psi yield strength is 5918, or 1.85 per cent above the high yield figure.

The possibility of an increase in collapse resistance by cold working induced the manufacturers of oil country goods to undertake a program of investigation. The cold rolling method for cold working had the advantage over the cold pressing method, used by this manufacturer, of adding materially to the longitudinal tensile properties as compared with the pressing method, and involved a smaller cost for both equipment and operation.

The results of tests of both methods when applied to seamless pipe were erratic. In general, the average collapse was lower than the Jasper and Sullivan stress curves indicated, and the spread much wider than for the hot rolled seamless product. A typical result is shown in Table V.

TABLE V

(Heat No. 4180, carbon 0.29 per cent, manganese 1.35 per cent)

	Specimen G-6	Specimen G-5
Class	Seamless hot-rolled	Cold-reduced 7.1 per cent
D/t	22.51	21.80
Test collapse pressure	3,925 psi	4,580 psi
Stewart SS formula P	4,112 psi	6,025 psi
P from Jasper & Sullivan curves (Figure 1)	4,190 psi	5,910 psi
Tensile properties		
Stress at 0.001 per cent offset	31,600 psi	35,000 psi
Stress at 0.010 per cent offset	41,700 psi	52,700 psi
Stress at 0.200 per cent offset	57,300 psi	85,700 psi

The agreement between the pressures calculated by the Stewart SS formula and the Jasper and Sullivan curves shown in Figure 1 is very good for both specimens. The test pressure for the hot-rolled specimen is also in good agreement with the pressures calculated by either method. But the test pressure of the cold-worked specimen is 29 per cent under the expectation.

The total strain theory applied to the stress-strain curves indicated that the failure to secure the expected increase in collapse resistance was probably caused by the low ratio of the proportional limit to the 0.2 per cent offset yield stress. This surmise gave a new direction to the investigation. It was learned that a suitable combination of steel qualities, amount of cold work, and a heat treatment following the cold work greatly improved the character of the stress-strain curves.

An example of one of the earlier trials of the process gave the results shown in Table VI.

The stress-strain curves of specimens G-5 and N-2 are shown in Figure 4.

As a result of this investigation, a process was developed and an arrangement of equipment for carrying out the method designed. The layout consisted of the usual seamless mill arrangement, the cooling table delivering over-sized pipe to a series of two high roll stands designed to effect diameter reductions up to 10 per cent. From the reducing mill, the pipe was moved at a speed of about 150 feet per minute through an induction heating coil with adjustable power input to raise the temperature of the heaviest pipe to approximately 900 F.

This equipment was not installed, as the current demand for the product did not justify the investment cost. A second reason for postponing installation was the development of the carbon-manganese-molybdenum alloy casing having a minimum specified yield strength of 80,000 psi. This alloy grade, meeting API specifications for Grade N-80 and the Code 5-C-2 collapse values, has served for well depths up to 12,000 feet and answered for much greater depths.

During the war, extensive drilling in deep territory increased the use of the N-80 grade of casing. This came at a time of serious alloy shortage. The situation promised to continue as the exhaustion of oil reserves indicated increased drilling depths. The situation promised an increasing field of use for the seamless work hardening process. Development work had continued after postponing the installation planned.

A new tool had come into use for the study of the resistance of pipe to external fluid pressure. This new tool was brought to the attention of the pipe industry by A. Nadai, who jointly with J. L. Holmquist, afterward presented a mathematical discussion of the subject in a paper called, "A Theoretical and Experimental Approach to the Problem of Collapse of Deep Well Casing." in API Drilling and Production Practice, 1939. A simplification of Nadai's formulae made to facilitate calculations is sufficiently accurate for many purposes. The simplified expressions are:

$$P=\frac{2\,E'}{(1-\mu^2)\,(D/t)^3} \quad \ldots\ldots(8)$$

$$E'=\frac{4\,E_1\,E}{(\sqrt{E_1}+\sqrt{E})^2} \quad \ldots\ldots(9)$$

$$P=\frac{2\,\sigma}{D/t} \quad \ldots\ldots(10)$$

E′ is the slope of the stress-strain curve at a given stress.

E¹ is the reduced or equivalent modulus. The relation (9) holds for pipe under external pressure. Equation (8) covers the entire stress range.

TABLE VI

(Heat No. 2349, carbon 0.37 per cent, manganese 0.95 per cent)

(Cold reduced 5.88 per cent then heated to 620 F, D/t = 21.01)

	Specimen N-2
Test collapse pressure	6,230 psi
Stewart SS formula P	5,920 psi
P from Jasper & Sullivan curves (Figure 1)	5,890 psi
Stress at 0.001 per cent offset	61,600 psi
Stress at 0.010 per cent offset	73,400 psi
Stress at 0.2 per cent offset	81,600 psi

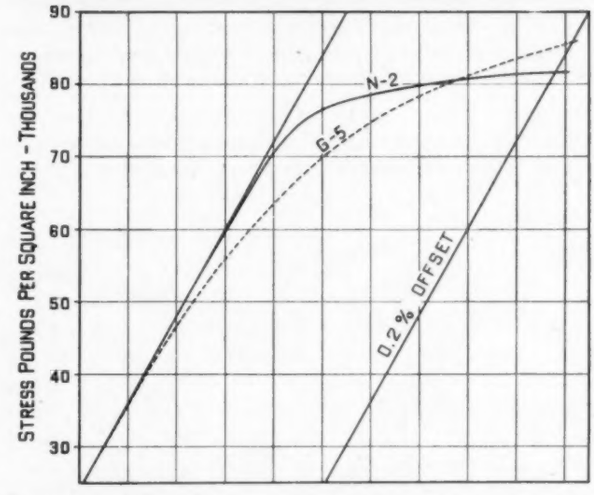


Figure 4 — Stress-strain curves of specimens G-5 and N-2 discussed in Tables V and VI.

▲

Figure 5 — Even if two materials have the same yield point, these curves show that the material with the lower proportional limit has a lower collapsing pressure.

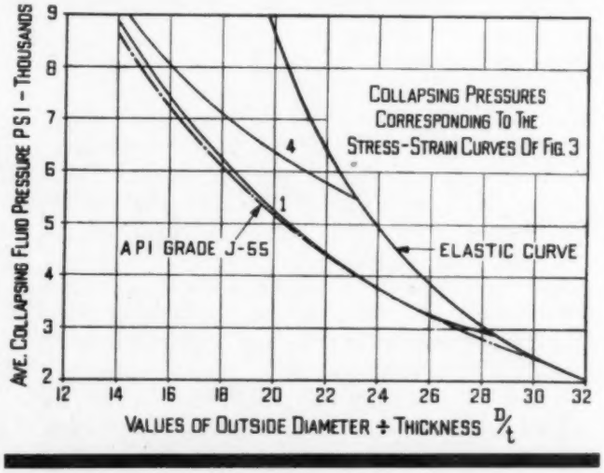


TABLE VII

Warm work results — 5.36 per cent reduction

Temperature of reduction	Yield strength, psi	Elongation per cent in 2 in.	Collapse pressure, psi	Increase in collapse over hot-rolled, per cent
Atmosphere	92,080	24.0	5,883	39.25
500 F	112,420	15.9	6,931	64.04
650 F	108,500	16.3	6,973	65.04
850 F	98,120	19.2	6,738	59.48
970 F	82,550	22.9	6,133	45.16

These equations made it possible to discriminate between the results of two collapse tests with a precision far greater than was possible by any of the methods used previously.

As an illustration of the use of these equations, and the dominating effect of the type of the stress-strain curve on the resistance of pipe to external pressure, the method is applied to the curves of Figure 3 as shown in Figure 5. The slope of the stress-strain curve is measured at a selected stress. The equivalent modulus is calculated by equation (9) and the D/t ratio for the stress by (10). The critical collapsing pressure is then determined by equation (8). Thus, a point is established on a line relating the D/t ratio to the critical collapsing pressure.

Figure 5 shows the critical collapse pressure D/t relation for stress-strain curves 1 and 4 of Figure 3. As the yield strength of these curves was placed arbitrarily at 65,000 psi, which is the value assigned to the yield strength of API Grade J-55 by Code 5-C-2, the critical collapse curve for that grade was drawn in for comparison.

It is evident from Figure 5 that it is useless to investigate any suspected cause for the variation in collapse resistance without first eliminating the enormous effect of differences in the stress-strain characteristics of the materials. It is also evident that a characteristic stress-strain relation is inherent in any expression relating collapse resistance to the pipe dimensions. This dictates the procedure for the evaluation of the collapse resistance of a pipe product class. The procedure is to determine by a statistical analysis the relation of the collapsing pressures to the nominal pipe dimensions for a sufficiently large number of test results on suitably selected specimens, together with the standard deviation of the test data. A practical form for expressing the results is that used in API Code 5-C-2 with an added factor expressing the probable expectation.

For failure at stress in the plastic range

$$P=(1\pm n\,q_1)\left(\frac{a}{D/t}-b\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots (11)$$

For failure at stress in the elastic range

$$P=(1\pm n\,q_2)\frac{c}{(D/t)_3} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (12)$$

n q is a multiple of the coefficient of variation
a b and c are experimental constants

The above described procedure was used in the further development of work hardening methods for the increase of the resistance of seamless pipe to external pressure.

Chemistry and hot-rolled physical properties

Heat number	12846
Carbon	0.41 per cent
Manganese	1.06 per cent
Phosphorus	0.015 per cent
Sulphur	0.020 per cent
Silicon	0.180 per cent
Yield strength	58,400 psi
Ultimate strength	102,600 psi
Elongation in 2 in.	26.5 per cent
Collapse pressure at D/t = 21.15	4,225 psi

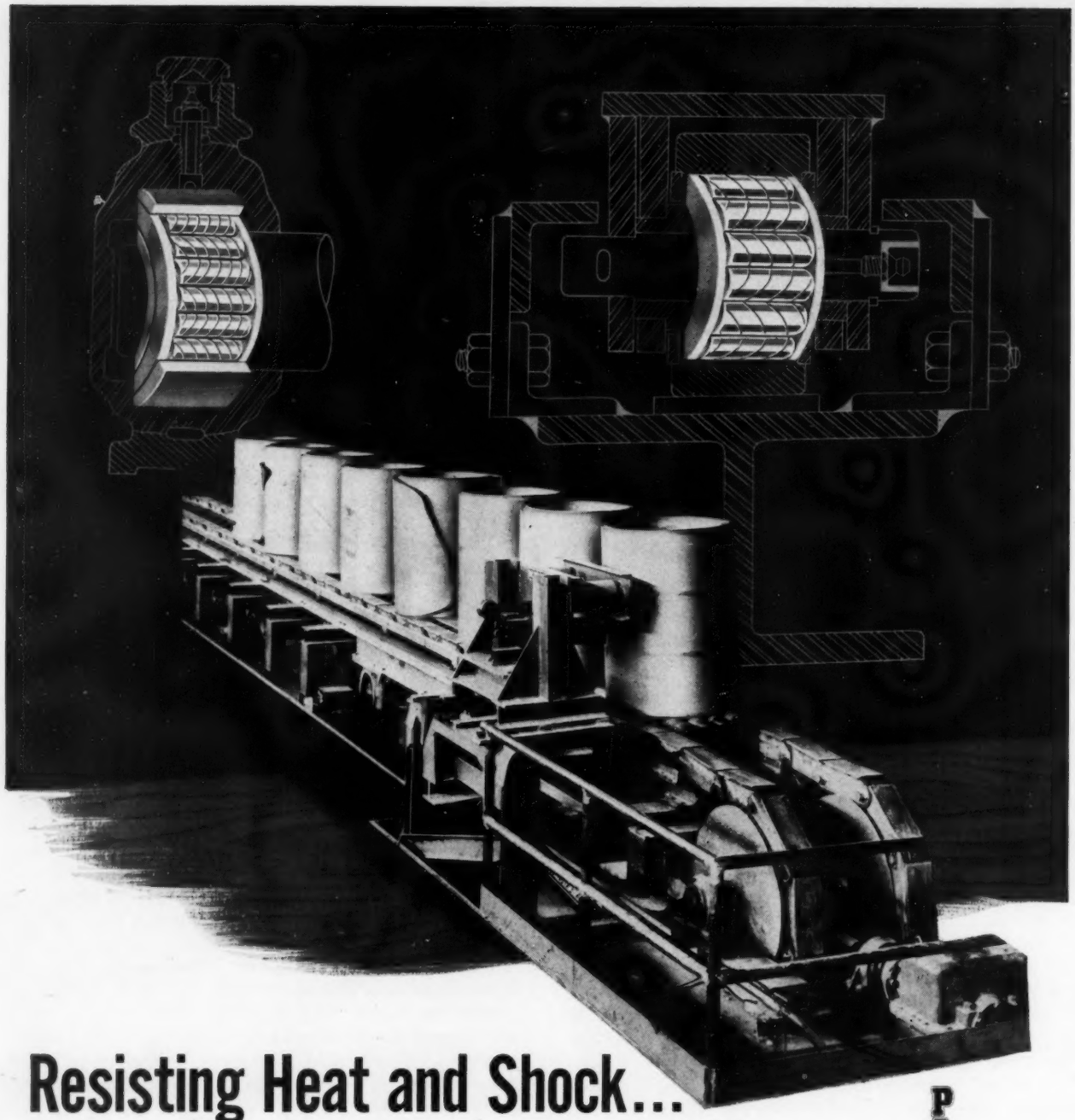
It has been found that, at a temperature suited to the material, the effect, whatever the action might be, on the stress-strain curve was practically instantaneous. This led to the idea that possibly the usual assumption that the effect of work hardening at temperatures above blue heat decreased and disappeared at the lower critical point, might not hold throughout the temperature range. Experiment established the idea to be a fact and also that such temperatures are effective in having an aging effect on the material hardened by being worked in such range. The original plan for work hardening was modified accordingly. Instead of delivering the pipe to a cooling table from the hot sizing operation, it is charged directly to a continuous furnace in which the temperature of the pipe is equalized and brought to the required level. From the equalizing furnace the pipe passes directly through the multiple stand reducing mill, and thence to the cooling table. The layout of the equipment provides for alternate lines of travel, one by-passing the work hardening process, and the other delivering the pipe from the hot sizing operation to a cooling table on which the temperature is reduced below the lower critical point. It is then charged to a continuous normalizing furnace, and from that furnace to the temperature equalizing furnace, then through the reducing mill.

The advantage resulting from the improved process is the extension of the range of the possible combinations of the physicals of the hot-rolled pipe, diameter reduction, and temperature at which the reduction is effected. The range of the properties for a steel class and constant diameter reduction at several temperatures are shown in Table VII.

The tensile properties prior to work hardening are the average of 12 tests. The collapse results of the work hardened pipe are the average of 6 tests at each temperature level corrected to the average ratio D/t = 21.15. The tensile properties are the average of two tests from each collapse test.

The process has been in production for the past six months, under a system of quality control insuring

(*Please turn to page 77*)



Resisting Heat and Shock...

BEARINGS: HYATT

PALMER BEE

Rolls of strip steel too hot to handle by ordinary methods and equipment are moved in huge volume on the special Palmer-Bee Hot Coil Conveyor—which loads, carries and transfers this material with minimum effort and maximum time saving. In the dustproof pillow block and chain plate assemblies of these conveyors, shafts are kept in alignment and turning friction-free with Hyatt Roller Bearings.

Not only in the handling equipment of steel mills, but also in all other kinds of machinery in industry, agriculture, and transportation, shafts stay aligned and gears and wheels turn freely on Hyatt Roller Bearings—literally millions of Hyatts.

HYATT BEARINGS DIVISION
GENERAL MOTORS CORPORATION
HARRISON, NEW JERSEY

War Development and Steel

. . . wartime research developed many new devices for military and other purposes . . . many of these devices have possible mill applications which are discussed in this paper . .

*by F. Mohler,** ENGINEER

STEEL MILL SECTION

GENERAL ELECTRIC COMPANY

SCHENECTADY, NEW YORK

▲ AMERICA amazed the world, and especially her enemies, in this war which we sincerely hope will be the last. To go from almost total unpreparedness to miraculous production of all the implements of war, almost overnight, was in itself enough to astound our enemies.

It was not just a question of increasing production, however. We not only required staggering quantities of material, but this material was most complex and highly scientific. It was necessary to not only reduce crude laboratory equipment to high speed production equipment, but to undertake almost untold research problems, solve them, and reduce them to production. Never before had the so-called "long-haired boys" been taken out of their world of experimenting, where time was of no consequence, and told to produce new ideas in nothing flat. Never before had designers been made to push their pencils and slip sticks so fast, and never before had the application engineers herded such a multitude of new developments into co-ordinated equipments with greater speed and accuracy.

The steel industry can justly be proud of the tremendous part it played, and likewise the electric industry can be proud of its contributions. These contributions are so numerous that only a small fraction of them can even be briefly mentioned. Furthermore, restrictions still imposed by our armed forces, make it impossible to describe in much detail some of the developments, or even mention some of the most interesting ones. Again, in some cases, it is impossible to give the background, reasons for, or the war applications of some of the equipment.

Presented before Philadelphia District Section Meeting, January 5, 1946.

*Mr. Mohler is now associated with the R. T. Patterson Company, Pittsburgh, Pa.

However, peacetime applications of these war developments can be almost limitless, and just as dramatic and important. Let us describe just a few and see where they might be used in the steel industry.

RADAR

Of course, one of the most talked-of developments, outside of the atomic bomb, is radar. You all are familiar with, and know the importance of this development, that it was responsible to a large degree for the success of our battleships, bombers and night fighters. Just recently released, we find that an adaptation of a tiny radar in the nose of a shell, known as the "proximity fuse," is really what stopped the kamikaze pilots. In many military minds, this development had more to do with the quick conclusion of the war with Japan than the atomic bomb.

What has radar got to do with steel? Well, it allowed one of the ore boats to operate on Lake Erie in fog that had always forced it to tie up before. See Figure 1. More boats would have been so equipped had the equipment not been so essential in combat. Incidentally, when first tried out, the Captain would have no part of this new-fangled contraption. However, a following ship showed up on the screen, and it was clear that it was headed for some projecting rocks. Finally, the Captain was prevailed upon to radio the ship and he was quite surprised, but convinced, when he found that the radar had not lied to him.

I have even had a request for a radar to be used as a

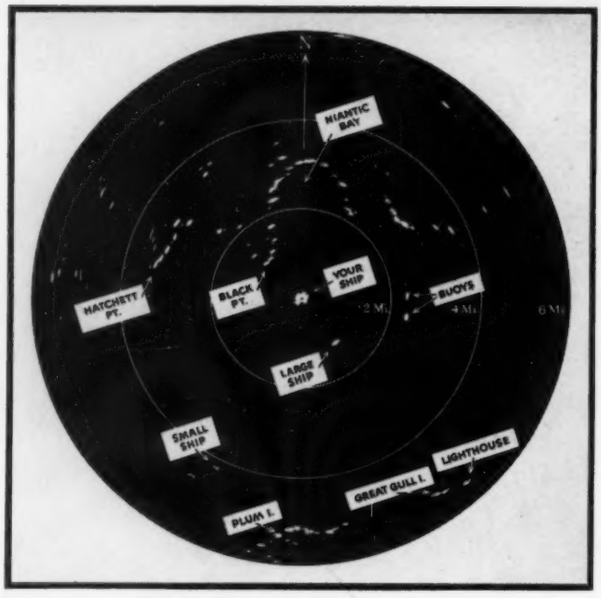


Figure 1 — The view of the radar screen in the ore boat shown gives valuable navigational help.

stockline recorder, but I don't believe we are quite ready for that yet.

X-RAY ANALYZER

The X-ray analyzer is an instrument for approximating the analysis of a material by comparing it with a known sample. It is based on the principle that the absorption of X-rays is a function of the number and kinds of atoms in a substance and is independent of the state whether it be gas, liquid or solid. The greater the atomic number of the element, the greater the absorption. Thus, the presence of lead in the lighter elements can be detected with an accuracy of 0.002 per cent. Or the presence of chlorine in the air, or in chlorinated plastics, can be detected with an accuracy of 1 per cent. This instrument may form the basis for a continuous measurement of the ash in the pulverized coal going into the boilers.

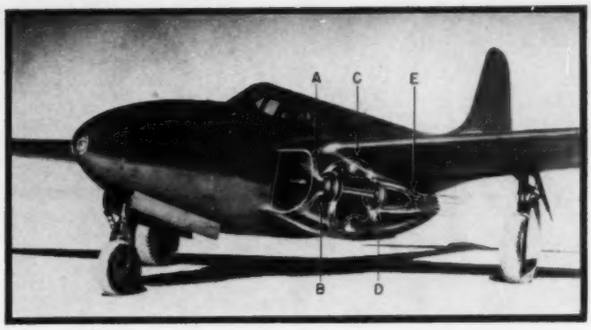


Figure 3 — The turbosupercharger now used in jet propelled planes may eventually generate power in the steel mill.

Figure 4 — This electro-hydraulic governor, used on a diesel engine, limits the maximum load on the engine. The model shown weighs 123 lb.

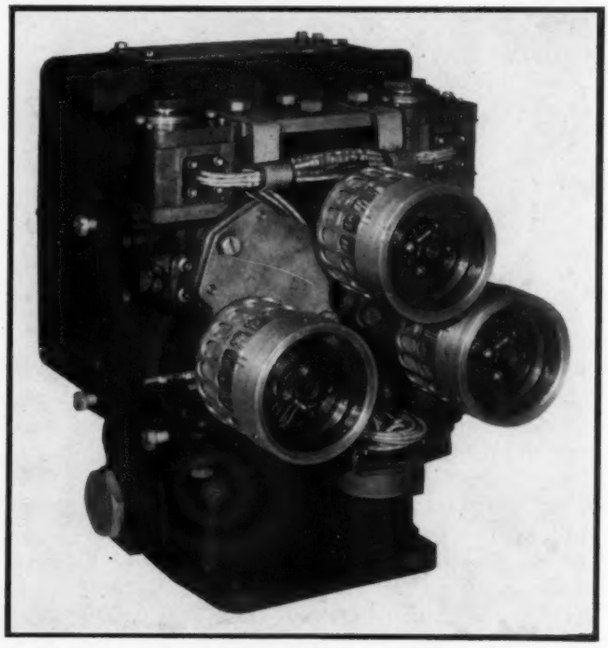
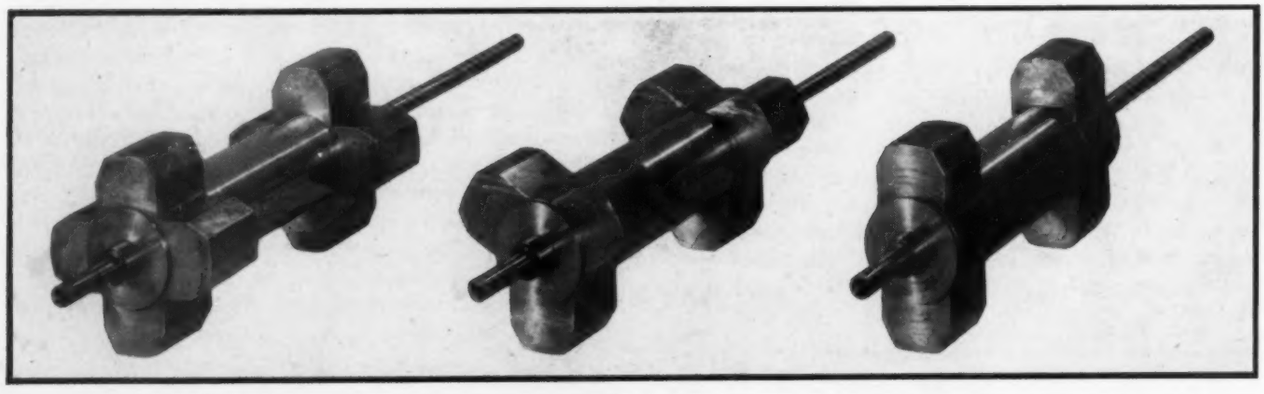


Figure 2 — These rotors are used in the sealed motors which were developed for use where leaks could not be tolerated.



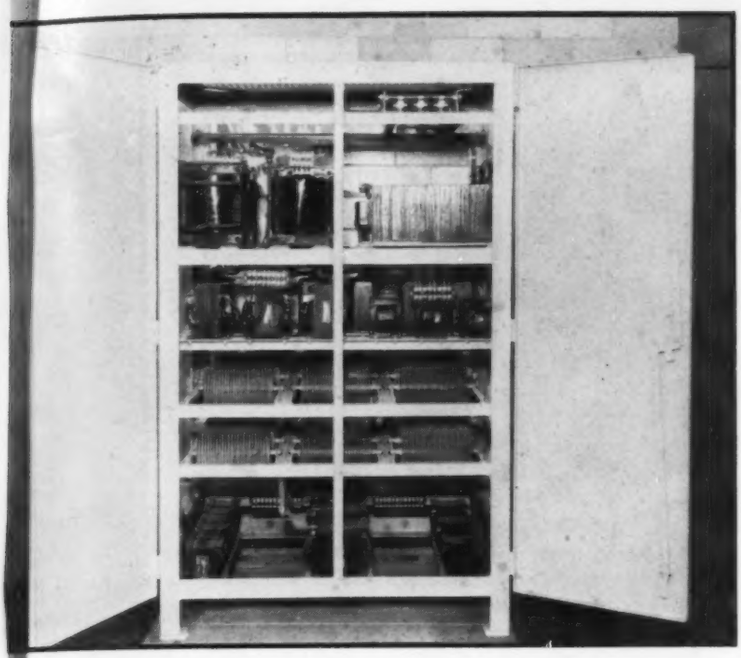


Figure 5 — The excitation equipment for the ignitron mercury-arc rectifier shown is rated 1500 kw, 250 volts, d-c, two-wire.

MASS SPECTOMETER

This equipment is used for high speed analysis of the quantities of the various gases in a mixture. A sample of the gas is introduced into an ionizing chamber, positively charged, and then magnetically propelled through a curved tube toward a target at the other end. The tube is equipped with baffles with a small hole in the center, so that a molecule must travel down the center of the tube to ever reach to target. Every element has a definite, but different, molecular weight. Thus, for a given magnetic field the lighter ones will move too fast, not being able to negotiate the turn, and the heavier one will turn too quickly. Only one element having just the right weight will tear down through the center and strike the target. The number of molecules striking the target can be readily indicated by the potential obtained. For every element, therefore, a definite magnetic field is required to get it to travel down the center and strike the target. By setting up a system of program control of the magnetic fields, the gas analysis can even be continuously recorded. Again, this instrument gives you a long needed tool for analyzing the tremendous quantities of gas coming from your blast furnace and coke ovens.

SEALED MOTORS

In several extremely important war processes involving pipe lines, tanks, etc., leaks could absolutely not be tolerated. Therefore, packings for pumps and valve operation had to be eliminated. Furthermore, because of corrosive action, the entire motor could not be placed inside. Therefore, motors were developed which allowed the rotors to be placed inside the pipes or process, and then operated by stators externally. For instance, a pump motor was built with a torque of 6.4 lb-ft at 400 rpm to operate with a $\frac{3}{8}$ in. thick brass process wall passing through the air gap. This type of motor may stop some of the dangerous gas leaks, or may solve some of your pump and valve maintenance problems.

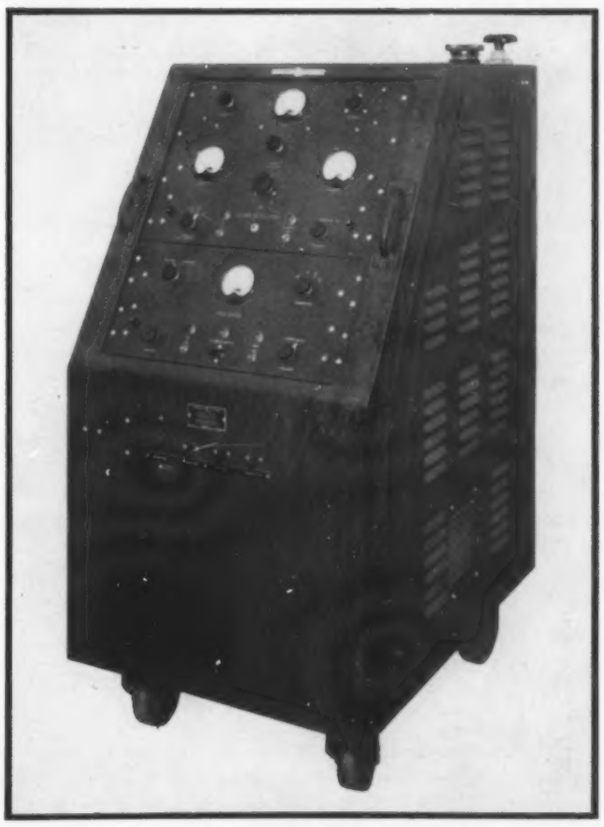
TURBOSUPERCHARGERS — JET PROPULSION — GAS TURBINES

Much has been written about turbosuperchargers, which have allowed our planes to fly higher and faster, and the remarkable job done on jet propulsion. This knowledge has formed the background for the gas turbine, and we may yet see them operating directly from our blast furnace or coke oven gas to generate the power for your mills.

ELECTRO-HYDRAULIC GOVERNOR

An emergency encountered under combat conditions caused the development of a special electro-hydraulic governor for engine-driven generator equipments. An

Figure 6 — The leak detector shown is really a mass spectrometer which is tuned for the gas that is being checked.



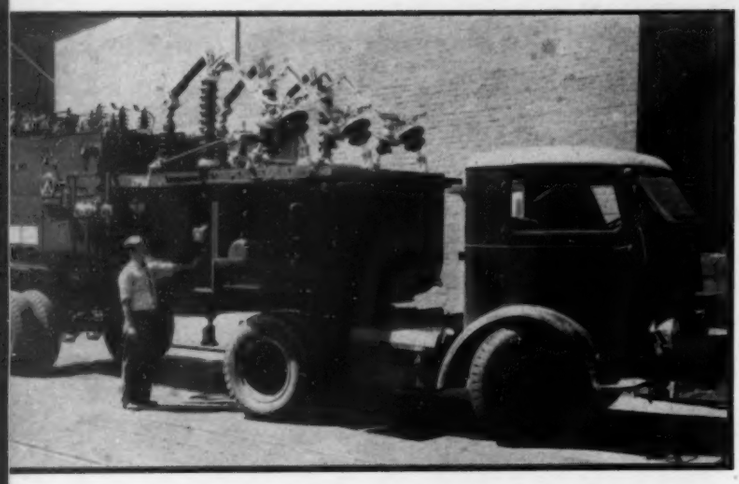


Figure 7 — The mobile substation shown is rated at 33,000 kva, and 33,000/13,200/2540/440/7620/13,200 volts. It has forced-oil circulation through the windings.

▲

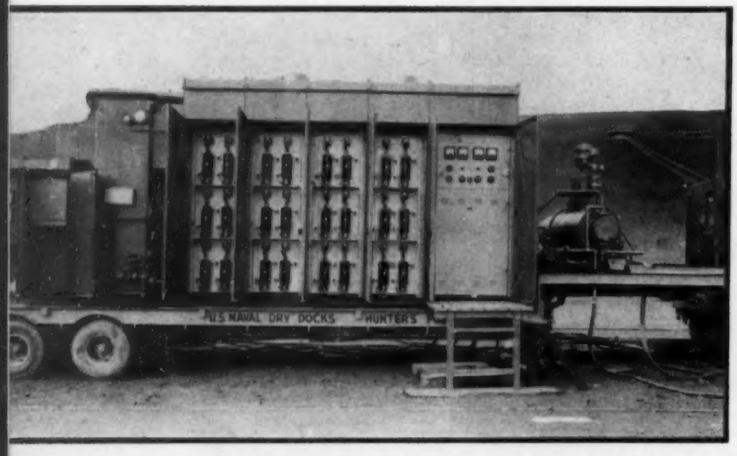
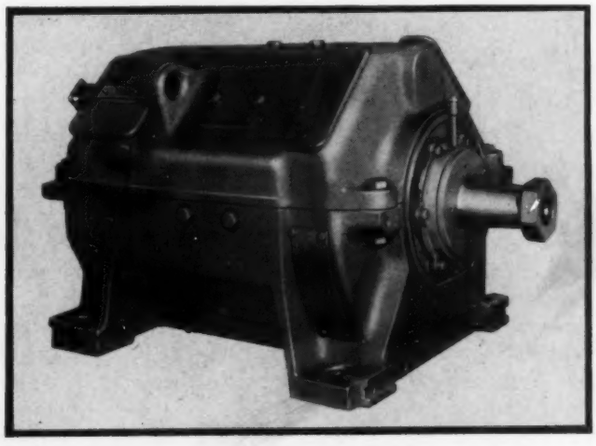


Figure 8 — This portable rectifier which is used for ship-side service in drydock is rated at 500 kw, 250 and 125 volts d-c, 3-wire.

Figure 9 — The silicone compound used on the porcelain insulating plate on the right has repelled the water. The uncoated plate on the left has been made useless by the same moisture.

▲

Figure 10 — The MD612 motor shown has a one hour mill rating of 75 hp, although its dimensions are that of the old 400 line 50 hp motor.



example is shown in Figure 4. This governor limits the maximum load on the engine under any condition of generator operation; it permits the engine to operate at any selected speed over a wide range; it permits the maximum motor speed, torque and load at the will of the operator within the operating ability of the engine at all times, and it provides proper division of load on engines operating in parallel. It will hold speed with extreme accuracy, as the system is isochronous. This new governor will be used on your diesel-electric locomotives to provide better performance with less maintenance. It may also be used on your turbine-generator power units.

RECTIFIERS

The development, during the war, of the tubeless or so-called static firing circuit shown in Figure 5, consisting merely of resistors, capacitors, transformers and rectifiers, has done much to increase reliability, improve performance, and reduce maintenance on the modern rectifier. Also, the development of a highly accurate leak detector, illustrated in Figure 6, is another forward step for building better rectifiers and metal electronic tubes. This detector is actually a mass spectrometer tuned for helium gas. The surface of an evacuated tank is explored with a small jet of helium and one leak out of 2000 equivalent leaks can be immediately detected.

Incidentally, approximately 3,500,000 kw in rectifiers were installed in the electro-chemical industry during the war for the production of aluminum, magnesium, chlorine and zinc.

PORTABILITY

Due to the terrific destruction during the war and the absolute dependence upon electricity, portability of electric equipment was developed to high degree.

One such unit is the 10,000 kw railway power plant built for the Navy. It is a complete power plant, including oil fired steam boiler, steam turbo-generator, switchgear, all accessory equipment, and even a laboratory.

Still another unit is the 30,000 kw floating power plant built for the Army. It, too, is complete and self-contained. One of these was stationed at Antwerp during the V-1 blitzkrieg, but fortunately was not damaged, although one of our men on board lost a little of his hair.

Figure 7 shows a portable unit substation with transformer, disconnects, lightning arresters, etc., for a-c power.

In Figure 8 is a portable rectifier for supplying d-c auxiliary power, complete with a-c and d-c switchgear.

The steel industry prides itself in continuity of service because "steel must roll." Possibly these may offer food for thought to take care of your emergencies.

SILICONES

Many interesting compounds of silicon, called silicones, have been developed during the war.

"Dri-film" is one form which is an excellent water repellent. Its properties are illustrated in Figure 9. It will waterproof ordinary cloth. It will prevent moisture from forming on insulators, and has been especially useful for this purpose in high altitude flying. It may solve some of your insulator maintenance problems.

Silicone oil is proving to have remarkable properties. There is relatively no change in viscosity over a very wide range of temperature. If it can be manufactured economically, this may be a lifesaver in some of your lubricating problems.

Silicone rubber was developed as gaskets for turbo-superchargers and Navy searchlights, because of the extremely wide changes in temperature encountered, particularly for the high temperatures.

These gaskets retain their elastic properties from — 60 to + 575 F.

Silicone insulation opens new fields in machine design as it is fairly non-hydroscopic, and stands temperatures, continuously, of 200 C without appreciable deterioration. Much experience needs to be gained, however, before wholesale applications are made. For instance; higher temperature solders and technique must be developed to fully realize the benefits. Likewise, experience must be gained with commutators, bind bands, etc. However, we are learning, and I am sure the steel industry will benefit by getting more reliable and probably less expensive electric equipment.

MILL TYPE MOTORS

The exacting requirements of modern war equipment, especially that of absolute reliability with minimum weight, taught us many lessons in regard to designing, to get the most out of the least amount of material. Using this "know-how" and recognizing the ever increasing cost of labor and material, we set about to

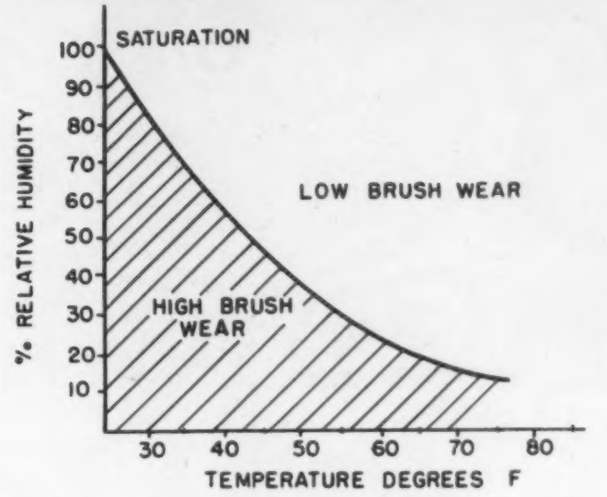


Figure 11 — The curve gives the relative humidity for various temperatures to maintain an absolute water vapor pressure of 3 mm of mercury.

redesign our mill type MD motor line. This motor is noted for its sturdiness, reliability, and performance. Furthermore, its ratings and dimensions have been standardized by the A.I.S.E. You might question the wisdom of our decision therefore to tackle such a difficult problem.

We, therefore, set as our goal to build the next larger rating in horsepower and speed into a given frame maintaining all the external dimensions exactly the same. Thus, for instance, the new MD-612 shown in Figure 10, would have the same horsepower and speed

Figure 12 — The electronic rotating control automatic screwdown control system is that for the 160 in. reversing plate mill of the Homestead works, Carnegie-Illinois Steel Corporation.

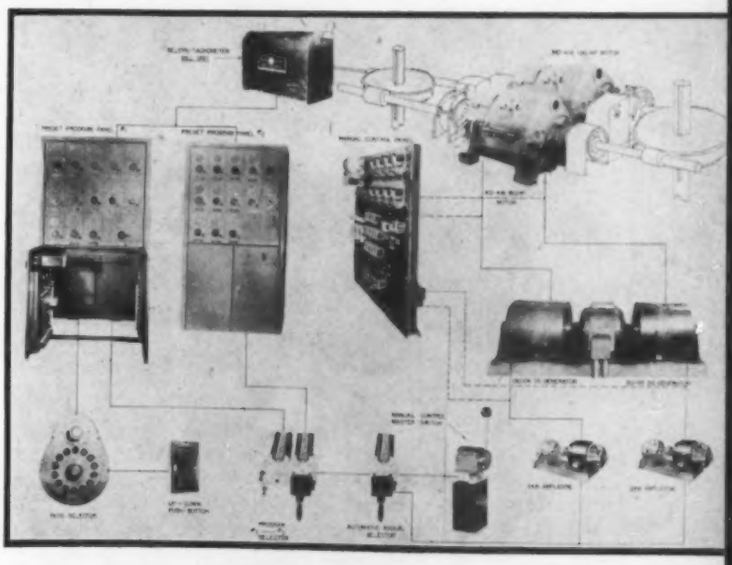


Figure 13 — X-ray inspection of hand grenades.

ratings as the old MD-414, but the dimension of the old MD-412. This means putting 75 hp into a 50 hp carcass. As a matter of fact, the MD-612 was the first rating built and tested, because it falls in about the middle of the range of frames. Next, an MD-602 representing the lower rating, and an MD-618 at the higher end were built and tested. The results have been more than gratifying. The performance from every standpoint — commutation, overload capacity, heating, speed regulation, speed stability, etc., are superior to the old line. Thus, we have a better performing yet less expensive motor, and what is extremely important, a motor with a lower WR^2. It is hoped that this new motor will be speedily adopted by the A.I.S.E.

BRUSH WEAR

One of your problems, brush wear, almost wrecked the B-29 program. As you know, the B-29 was designed on the basis that all turrets be electrically operated and remote controlled, not just for the fun of it, but because of the vulnerability of the ship to attack due to its size. In addition, the wind pressure was too great for men to manually operate the guns. The plane was full of d-c motors and amplidyne generators, and it was quickly found that brushes would last only a matter of minutes in some cases. Research was started immediately on the fundamentals involved in brush wear, and it was found that the predominating factor was the number of grains of water in the air. At a water vapor pressure of zero, the wear was one millimeter per minute and at 2.5 millimeters of mercury, it was down to 0.01 millimeter per minute. For minimum brush wear, a water vapor pressure of 3 millimeters of mercury is about right. For this optimum value of water pressure, the curve of Figure 11 shows the proper humidity which should be maintained for various temperatures. You may then add the necessary steam to the ventilating air to bring the water content up to the proper value.

AUTOMATIC SCREWDOWN CONTROL

The selsyn-electronic-amplidyne system has extreme accuracy, even under transient operation. It is the fundamental system employed in our new automatic screwdown control an example of which is given in Figure 12. It will probably be used in connection with certain processing line flying shears.

CONTOUR CONTROL

The problem was presented us to design a control to cut gun barrel stocks on a lathe, mind you, so as to speed up production. An electronic system was developed whereby a feeler bore against and explored the surface of a model, and the cutting tool on the lathe followed faithfully and with remarkable accuracy. Many

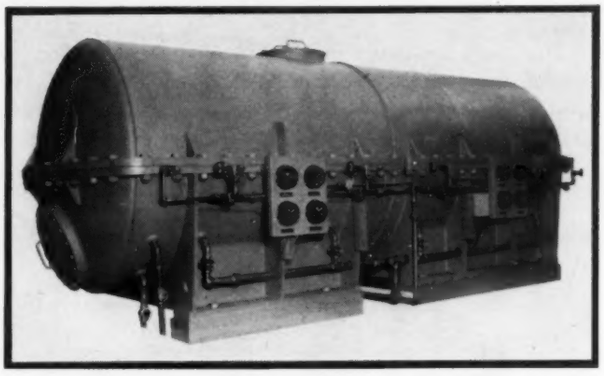


Figure 14 — Illustrated is a hydrogen-cooled frequency changer rated at 700 kw, 3600 rpm, 60-9600 cycles.

adaptations to metal working lathes and milling machines have been made. It may be adopted by you for accurately grinding rolls to special curvatures and intricate lathe and milling machine work.

X-RAY INSPECTION

It was necessary to guard against premature explosions of hand grenades, and hundreds of thousands of these grenades were dropped in our lap to be inspected with no known means of doing so. It was found that the difficulty was due to the improper filling of fuses. The question was how to inspect them, X-ray would do the job, but taking an X-ray photograph of each grenade and then developing it seemed hopeless. A new X-ray system, shown in Figure 13, which made it unnecessary to take photographs, was developed, however, whereby these grenades could be inspected at the rate of 4000 an hour, the faulty ones automatically marked with red paint, and a signal sounded at the same time. This equipment is the foundation for the non-contacting X-ray thickness gage being developed for use on hot and cold strip mills.

HIGH FREQUENCY

The development and use of high frequency induction heating during the war for heat treating, annealing, soldering and brazing played no small part in its outcome. Many papers have been presented on this, but

in passing, I would like to mention that as an outgrowth, we are now building a high-frequency annealing furnace for a continuous galvanizing line. It will be supplied from two 700 kw, 9600 cycle induction motor-generator sets, and used to raise the temperature up to 1300 F.

HIGH SPEED COUNTER

Figure 15 shows a high-speed counter which consists of a counter and a special driving motor having four stators and six rotor poles. On each d-c impulse on the stator, the motor will notch up one pole and one digit. It will count at the rate of sixty times per second. The steel industry has many high speed counting problems, especially in the handling of tin plates.

HIGH SPEED TIMER

Figure 16 shows a timer consisting of a 100 rpm synchronous motor driving a counter equipped with limit switches which can be set to trip on any digit. It can be set at 0.01 minute increments from 0.01 to 999.99 minutes, and time faithfully and accurately. This device will help solve many problems in making processes automatic. It may be used for starting a flying shear, for instance, a definite time after the end of the strip passes a certain point in the mill.

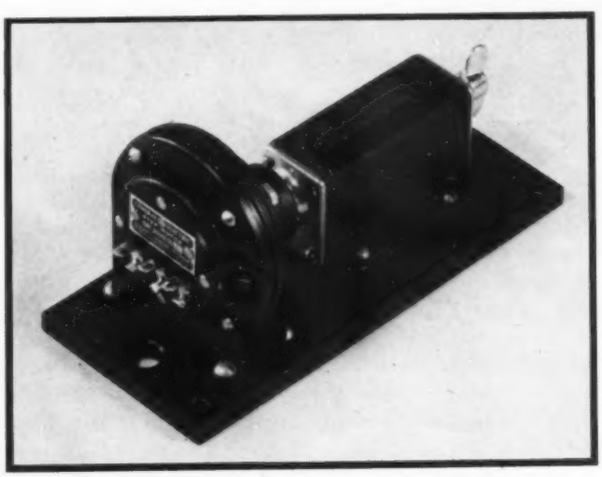


Figure 15 — This high speed counter can count at a rate of sixty times per second.

RESEARCH AND ENGINEERING

To me, probably the most outstanding developments during the war that will have the most far reaching results in the steel industry are the tools and facilities

Figure 16 — The high speed timer can be set for intervals as low as 0.01 minutes.

made available to the engineer for research and the study of design and application problems.

In one year, more than 2000 new or modified instruments were developed. If you can measure it, you know something about it, and if you know something about it, you can control it.

For example, the industrial control division now has at its own disposal a most thoroughly equipped research laboratory for developing and testing new designs. One item, in this laboratory is the arc timer, shown in Figure 17, which will measure instantly the arcing time of a contactor rather than the old laborious method of taking an oscillographic record, developing the film, calibrating it, and then calculating the result. More than 4,000,000 shots have been taken with this timer, imagine taking that many oscillographic films. Another is the travel recorder, which accurately draws

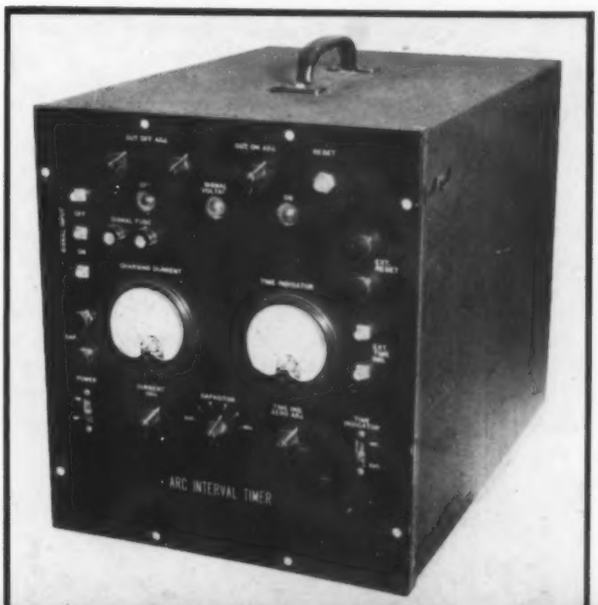


Figure 17 — This portable arc timer is used to measure arcing time of contactors.

Figure 18 — The differential analyzer enables complex equations to be solved which could not previously be economically computed.

a picture of the travel of a device with respect to time, say for instance, the armature of a contactor. Another is the bounce recorder, and you know that bounce in a magnetic device means maintenance. Think of the boon to proper design given by just these three tools.

We used to think we built sturdy control and switchgear for the steel industry until we put it under the 2000 pound shock test required by the Navy. Now we know how to build it.

We have had, for some time, the d-c calculating board, the a-c network analyzer, and the transient analyzer to assist us in solving intricate network problems. However, so many complex mathematical problems came up during the war that they staggered the imagination. So we now have the high-speed differential analyzer, shown in Figure 18, for quickly solving the most complex equations. This has and will enable us to make engineering analyses that just could not be tackled without it, because of the time involved. The steel industry cannot help but benefit.

DISCUSSION

PRESENTED BY

F. O. SCHNURE, Electrical Superintendent, Bethlehem Steel Company, Sparrows Point, Maryland.

L. F. COFFIN, Superintendent Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland.

A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland.

H. H. ANGEL, Electrical Department, Bethlehem Steel Company, Sparrows Point, Maryland.

R. E. MILLER, General Foreman, Bethlehem Steel Company, Sparrows Point, Maryland.

F. MOHLER, Engineer, Steel Mill Section, General Electric Company, Schenectady, New York.

F. O. Schnure: To us at Sparrows Point, the reference to the devices that could be used in strip mills, such as the high-speed counting devices, the X-ray thickness gauge and others, was of particular interest. The X-ray gauge is a device that could have been used since electrolytic tinning became general practice had it not been for the war holding up such development.

Of extreme interest was the statement that higher horsepower ratings per frame can now be supplied in the mill type motor line. This will provide a simple method of correcting undermotored jobs. However at the moment, I am not too enthusiastic about starting a new line of mill type motors, although if the new rating remains a mechanical duplicate of the original frame, no serious difficulty should be experienced.

L. F. Coffin: I would like to ask Mr. Mohler to discuss the thickness gauge; as to its adaptability for hot and cold steel and as to what happens to its accuracy when there is scale on the steel?

A. J. Fisher: Mr. Mohler spoke of a galvanizing operation. I would like to ask him what kinds of material are being contemplated for that operation?

H. H. Angel: This question does not apply necessarily to Mr. Mohler, it applies to all of the manufacturers. I am looking forward to the manufacture of crane or mill switchboards in the future which will have the ability to withstand terrible punishment in controlling motors, but will be, at the same time, about three-quarters or one-half of the present size. This would be especially valuable, of course, on overhead cranes.

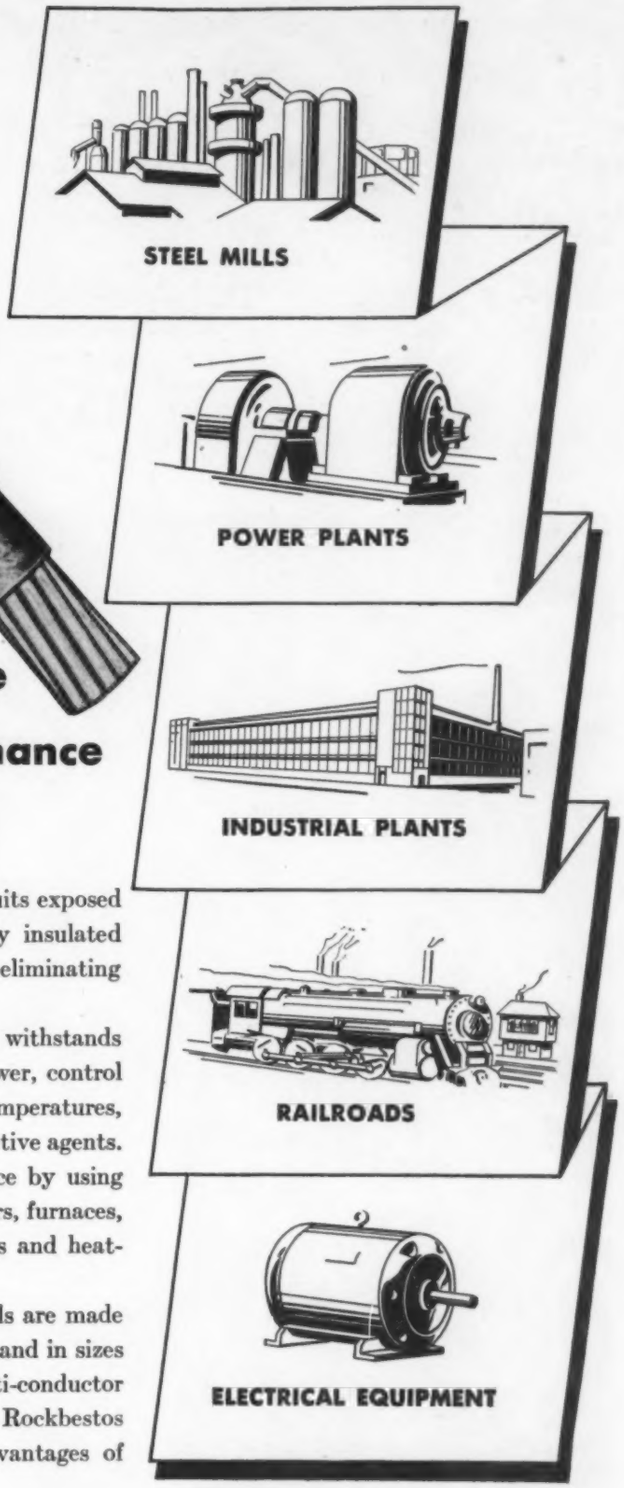
R. E. Miller: Is it not a fact that the metallurgy of the material to be measured affects the accuracy of the thickness gauge that Mr. Mohler describes?

F. Mohler: Referring to Mr. Coffin's questions in regard to the X-ray thickness gauge, I would first like to describe very briefly the operating principles of this gauge. The absorption of X-rays is dependent upon the atomic weight of any material. This is true of paper, glass, steel or any other type of material. Thus, if X-rays are projected through a sheet of steel, the amount of rays passing through the steel is inversely proportional to the thickness. If the rays which pass through the steel are projected on the phosphorescent screen, the degree of illumination is also proportional to the thickness of the steel.

Thus, the accuracy of the X-ray thickness gauge is dependent upon the analysis of the steel which, of course, affects its atomic weight. However, it is believed that the atomic weight does not vary greatly over quite a range of products, and that at least several calibrations can be used to cover the whole range of steel products rolled on a hot strip mill. Scale, of course, will affect the accuracy since the X-ray does not know whether it is measuring the steel or scale. Likewise, an oil film would affect the accuracy. However, it is believed that this can be compensated for so that the final result is within the tolerances desired. Only a trial installation will settle these various points definitely, and we hope to have a trial installation within the next year.

Referring to Mr. Fisher's question in regard to the

(*Please turn to page 77*)



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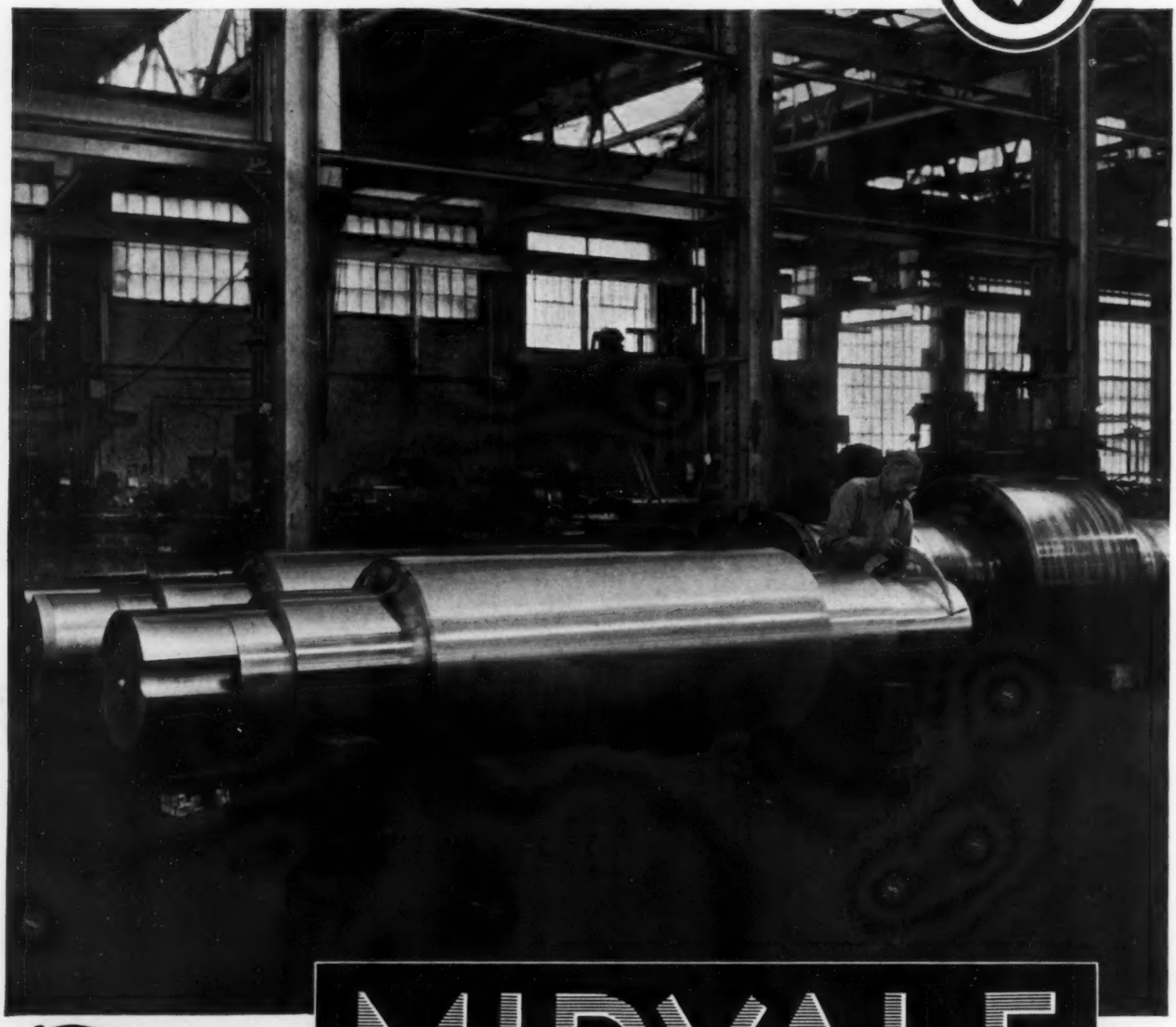

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Statistical Control in Manufacturing Steel Strips and Tin Plate

. . . although only in operation for a few months, statistical control has improved overall quality of tin plate and reduced rejects to a marked degree . . .

by M. M. Armstrong

ONTARIO RESEARCH FOUNDATION

TORONTO, CANADA

▲ THE increasing size and complexity of the modern steel industry has made it impossible for the works manager or even the superintendent of a large department to have personal knowledge of the many changes which occur daily in the processes or products under his supervision. For this information he must necessarily rely on written reports from the foremen of the various divisions of the production, inspection and maintenance departments. Analysis of the mass of figures contained in such reports is, in itself, often difficult and has little meaning unless it can be compared with the records of past performance.

During recent years, statistical methods have been used in many industries to reduce large masses of data to simple graphical forms which show past performance levels and general production or quality variation. Such methods have provided a new tool for management, whereby decisions may be made on a factual statistical basis. It has often been said that statistical control provides the missing link between production, inspection and engineering.

The management of Dominion Foundries and Steel Limited were among the first to apply statistical control methods to large scale steel plant operations during World War II. The wartime program, under the direction of F. H. Sherman, then manager of the armor plate department, was set up first as a fact finding and data recording service, but evolved into a control system which was responsible to a considerable degree for the uniformly high quality and production of armor plate and gun steel produced by this company.

With the cessation of hostilities, it was decided that similar benefits might be obtained if similar control methods were applied to the manufacture of steel strip and tin plate, and such a program was started in November 1945.

The following difficulties were immediately apparent:

1. Since tin plate, by comparison with armor plate, was a low-priced product, the application of quality control must not add appreciably to the existing cost of inspection.
2. The inspection of cold strip and tin plate was based, to a large extent, on visual characteristics and not on measurable factors.
3. The finished product was not linked closely with preceding rolling and finishing operations by a foolproof system of identification.
4. The final sorting room inspection provided records of the total primes, menders, seconds and waste from all pots, but gave no breakdown of the causes of rejection or the pots in which the defective material was produced.
5. The psychological aspects of this application also presented difficulties. The basic methods of tin plate manufacture have been established for many decades and are generally considered to be more art than science. On the other hand, the manufacture of armor plate was a new development in this plant and process changes were expected and adopted quite readily. There was little or none of the resistance to change which was often apparent in the later investigations.

These and similar problems necessitated the development of many new record forms and improved systems of data collection. A few breaks still exist in the flow of operating data but most of the key processes now

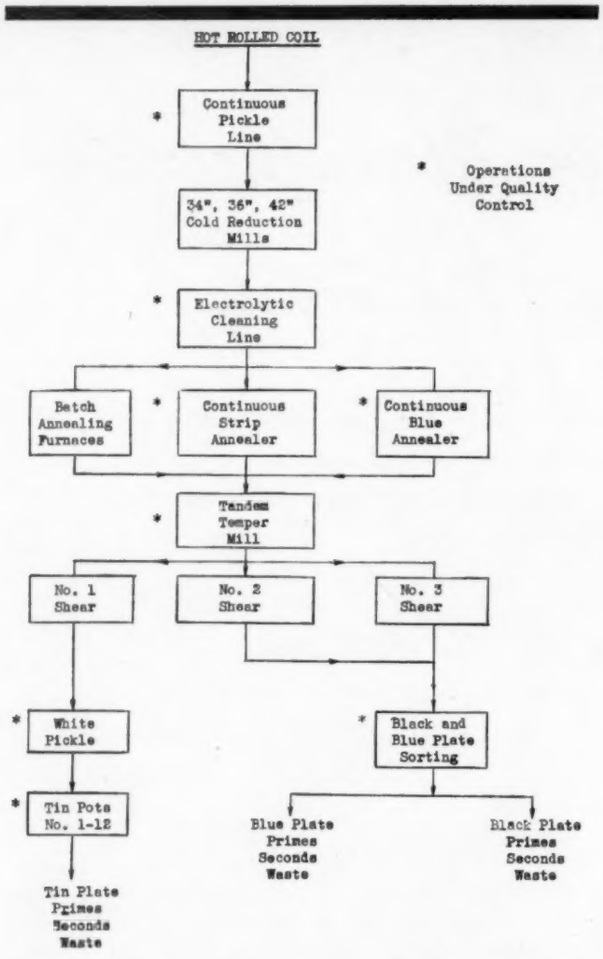


Figure 1 — Flow sheet shows steps in the processing of the coil to the finished plate.

▲

Figure 2 — An example of a daily average temperature chart for a cleaning line electrolytic tank.

operate under quality control. This is shown by the flow sheet in Figure I.

The data collected is listed in Tables I, II, and III. The information collected by the control office may be divided into four general classifications:

1. Process variables affecting quality. (See Table I).
   a. Acid content and temperature of pickling solutions.
   b. Oil and metal temperature in tin pots.
   c. Weight and spread of tin coatings.

   These and similar data are reported by chemical laboratories and metallurgical observers or may be taken from instrument charts. They are plotted as daily averages and ranges. In some cases no method of measurement was available and special instruments were either built or purchased. Examples of control charts are shown in Figures 2 and 3.
2. Process variables affecting production. (See Table I).

   Operating and maintenance delays on each process are plotted as a percentage of total operating time along with the daily production of that process. also, the detailed causes of such delays are shown by a colored histogram. Delay charts are shown in Figures 4 and 5.

The possibility of improving operating efficiency by the study of delays has been realized during recent years in many organizations, but the problem of stoppages has generally been neglected. Stops of under 3 to 5 minutes duration are generally not listed as delays. Machines such as tin pots, continuous bluing furnaces, etc., may make as many as 75 such stops during a 24 hour day and the total of such stops will often be a considerable fraction of the total operating time. In the case of the two processes mentioned above, stops have an even more serious effect on product quality, since the percentages of off-colour plate in one case and tin plate menders in the other are greatly increased. For these reasons existing control instruments have been altered or new instruments installed to record stops on such

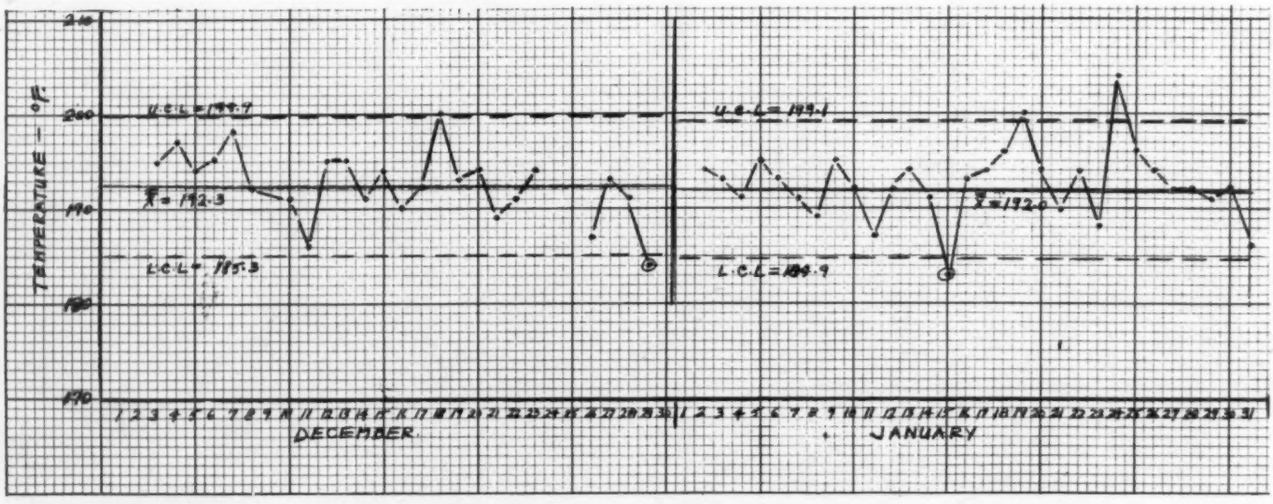


TABLE I

PROCESS VARIABLES

Continuous Pickle Line	Type of Record
Acid content, each of 3 tanks	Daily average chart, "$\bar{x}$" chart.
Range of acid content in each of three tanks	Range chart, "R" chart.
Baume readings, each tank	Single point chart, "x" chart.
Production, tons per day	"x" chart.
Operating delays	Percentage of total operating time, "p" chart.
Maintenance delays	
Total delays	Coloured histogram showing causes of delays accompanies each chart.
Number of stops per day	Plotted as number of stops, "c" chart.
Cleaning Line	
Na_2O contents of spray tank and electrolytic tanks	Daily average or "$\bar{x}$" charts.
Temperature of each tank	
Range of Na_2O and temperature for each tank	Range or "R" chart.
Production, tons per day	"x" charts.
Operating, maintenance and total delays, (3 charts with histograms)	Percentage of total operating time, "p" chart.
Number of stops per day	"c" chart.
Continuous Annealing Furnace	
Per cent of coils re-annealed per shift	"p" chart.
Rockwell hardness, each coil	Recorded only.
Furnace speeds and temperatures	Recorded only.
Operating, maintenance and total delays, (3 charts with histograms)	"p" charts.
Number of stops per day	"c" charts.
Production, tons per day	
Blue Annealing Furnace	
Operating, maintenance and total delays, (3 charts with histograms)	"p" charts.
Number of stops per day	"c" charts.
Production, tons per day	
Temper Mill	
Number of coils between roll changes	"c" chart.
Condition of rolls and strip	Recorded only.
Rockwell hardness, each coil	Recorded only.
Shear Lines	
Shear burr, each line	Daily average, "$\bar{x}$" chart.
Shape (Wavy edges, scratches, etc.)	Recorded only.
White Pickle	
Acid content and temperature	Daily average or "$\bar{x}$" chart.
Range of acid and temperature	Range or "R" chart.
Tin Pots	
Pot yield per day, (each pot)	"X" chart.
Coating spread per day, (each pot)	Daily average, "$\bar{x}$" chart.
Oil viscosity, (each pot)	Daily average, "$\bar{x}$" chart.
Oil temperature, (each pot)	Low value for day as "x" chart.
Metal temperature, (each pot)	Range for day as "R" chart.
Number of stops per day (each pot)	"c" chart.

TABLE II

PRODUCT VARIABLES

Hot Rolled Coils	Type of Record
Percentage of clean coils per day from pickle line	"p" chart.
Percentage of laminated steel removed at pickle line	"p" chart.
Tin Plate	
Menders, (per cent of total product)	"p" chart with histogram of causes.
Menders, each pot	Individual pot charts show reasons for high values, machine changes, types of brushes, drossing time, metal added, etc.
Seconds as per cent of total produced and also as per cent of plate shipped	"p" charts.
Seconds produced by each pot	
Waste as per cent of total production and also for each pot	"p" charts.
Separate charts are also plotted for the more important defects such as beads, white caps, dry plate, scale, wavy plate, etc.	
Black Plate	
Seconds, waste, off-gauge	"p" charts with histograms showing reasons for rejection.
Blue Plate	
Seconds, waste, off-gauge, re-roll, etc	"p" charts with histograms showing reasons for rejection.

operations as continuous pickling, continuous annealing, blue annealing and tin plate.

3. Product variables. (See Table II).

Data on product quality are recorded at various points during the process and in the final sorting-room inspection. Since most of the quality characteristics of steel strip and tin plate are determined by visual inspection, such information is plotted as percentage defective charts as follows, per cent clean coils at pickle line, and per cent menders, seconds, waste from tin pots.

A percentage defective chart with the accompanying colored histogram showing causes of rejection is shown in Figure 6. The results of tin-plate inspection are reported in such a way that the quality of plate produced by each pot or even one side of a single pot may be studied either on a shift or daily basis. Also the individual causes of rejection such as white caps, beads, scale, dry plate, etc., are shown. Figure 7 shows the inspection form used to report this information.

The final quality charts are used to show all process changes. In the case of the tinning operation, the individual pot charts carry notes of all machine changes, drossings, types of brushes used, etc. In this way the effect of process changes on quality levels may be determined.

4. Costs and yields. (See Table III).

The costs and yields of many operations are shown by control charts. These serve mainly as a source of data for management decisions, but may also indicate which operations are most lacking in operating efficiency and control. The details of the statistical methods employed will not be discussed in the main body of this paper, but are outlined in considerable detail in the appendix. The place of the control department in the organization and the methods of reporting findings and taking action in matters of

process change have more influence on the final success of such an application than do the methods of calculating and plotting data.

The control department may operate as a part of the existing metallurgical or inspection departments, but is usually more effective as a tool of top management. In such cases it should be directly responsible to the plant manager and the necessary authority for process changes or other action procedures should come from that official.

The effectiveness of a control system depends on the following factors:

1. Full support from top management. The executive group should understand the possible gains which may result from application of statistical control and have some general knowledge of the methods used to report findings. It may be necessary to make a plant survey and report on the processes to which this type of control is most applicable. A trial application to demonstrate actual money savings will usually convince even the strongest reactionary.

2. Cooperation of production supervisors and foremen. These men must be made to understand that the control system is not some method of time-study or job evaluation which will criticize their individual skills or decrease their earning power. Many organizations have given in-plant courses in statistical quality control to these key men with very satisfactory results.

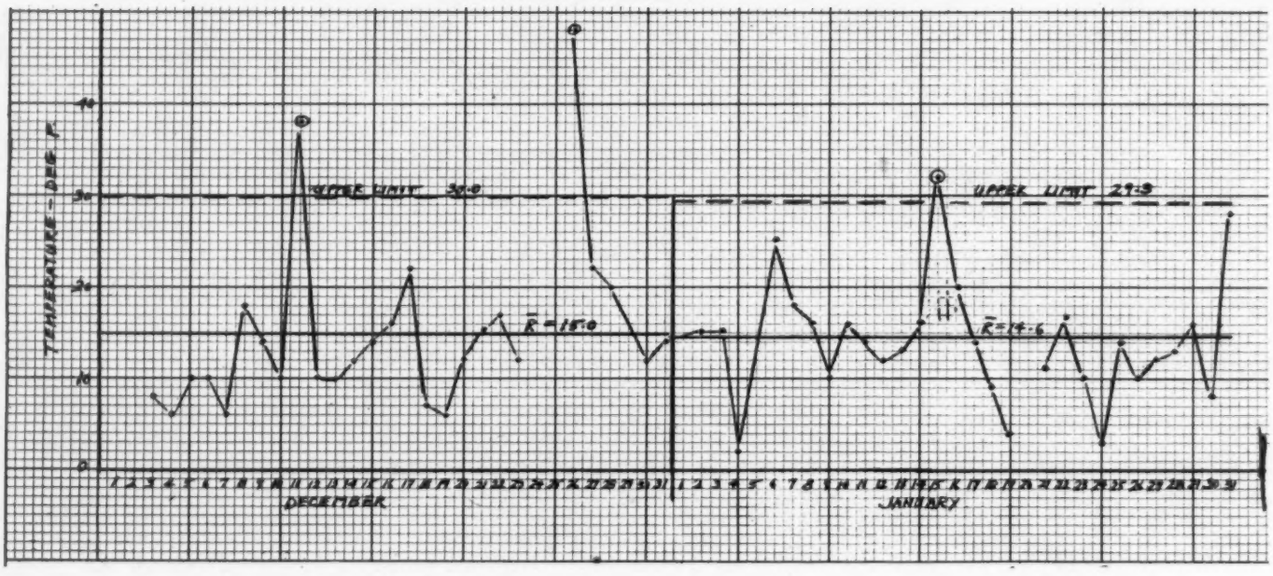


Figure 3 — An example of a daily temperature range chart for a cleaning line electrolytic tank.

▲

Figure 4 — Typical operating delay chart.

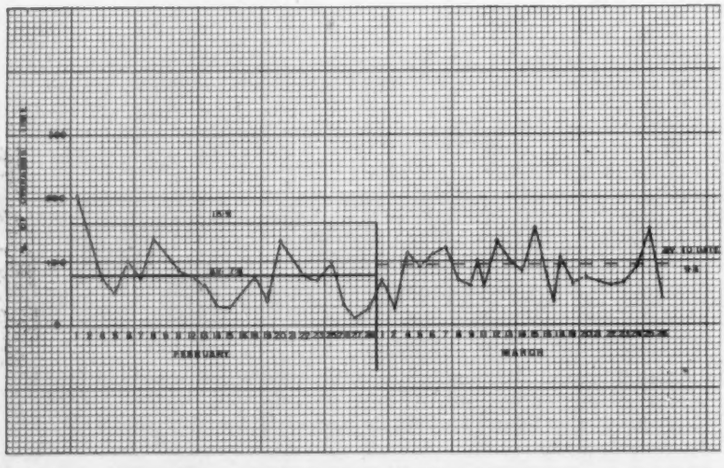


TABLE III

COSTS AND YIELDS

Net yield hot-coil to sheared plate	Daily values.
Shearing yield — Blue plate	Daily values.
Shearing yield — Black plate	Daily values.
Pickle line yield (daily)	Daily values.
Pickle line cost	Daily values.
Cold mill cost	Daily values.
Cleaning line cost	Daily values.
Batch anneal cost	Daily values.
Continuous anneal cost	Daily values.
Blue anneal cost	Daily values
Temper mill cost	Daily values.
Shearing cost	Daily values.
Tin coating cost	Daily values.
Tin plate sorting room cost	Daily values.
Black plate sorting room cost	Daily values.
Blue plate sorting room cost	Daily values.

3. Effective action procedure must be established. A memo and reply form has been used with success at Dominion Foundries and Steel Limited to point variations from standard practice to production personnel. A blueprint of the control chart in question may also be sent to the department concerned. The psychological effect of a quality control system

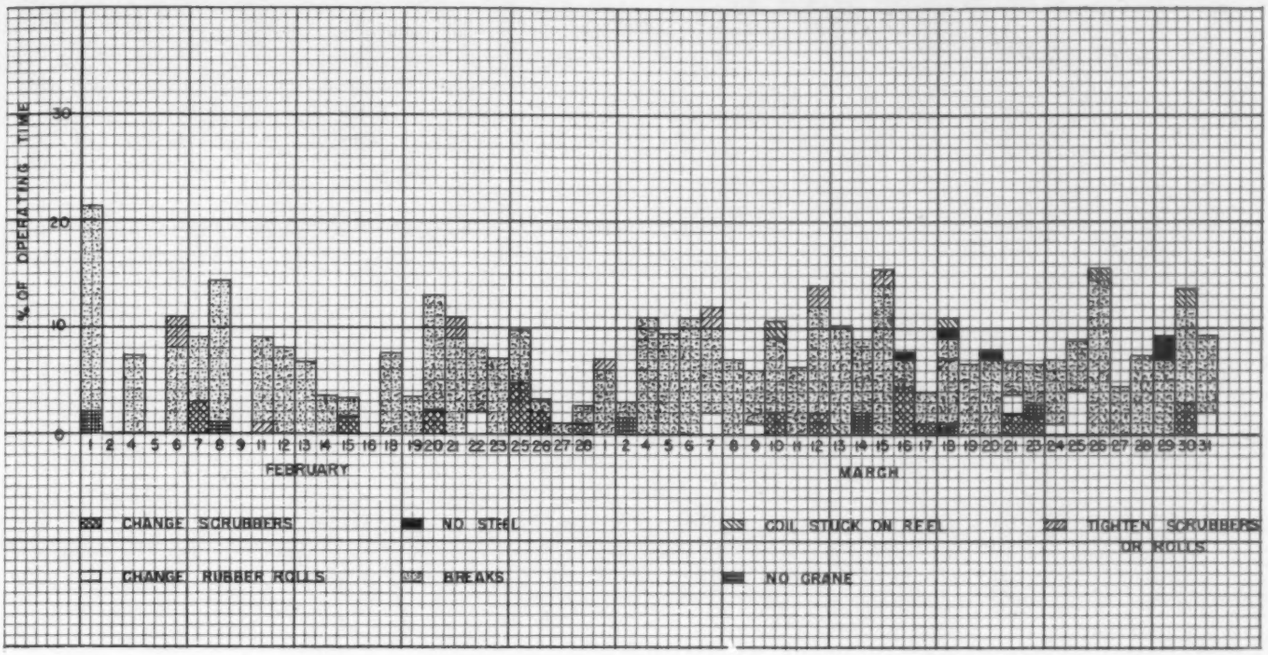
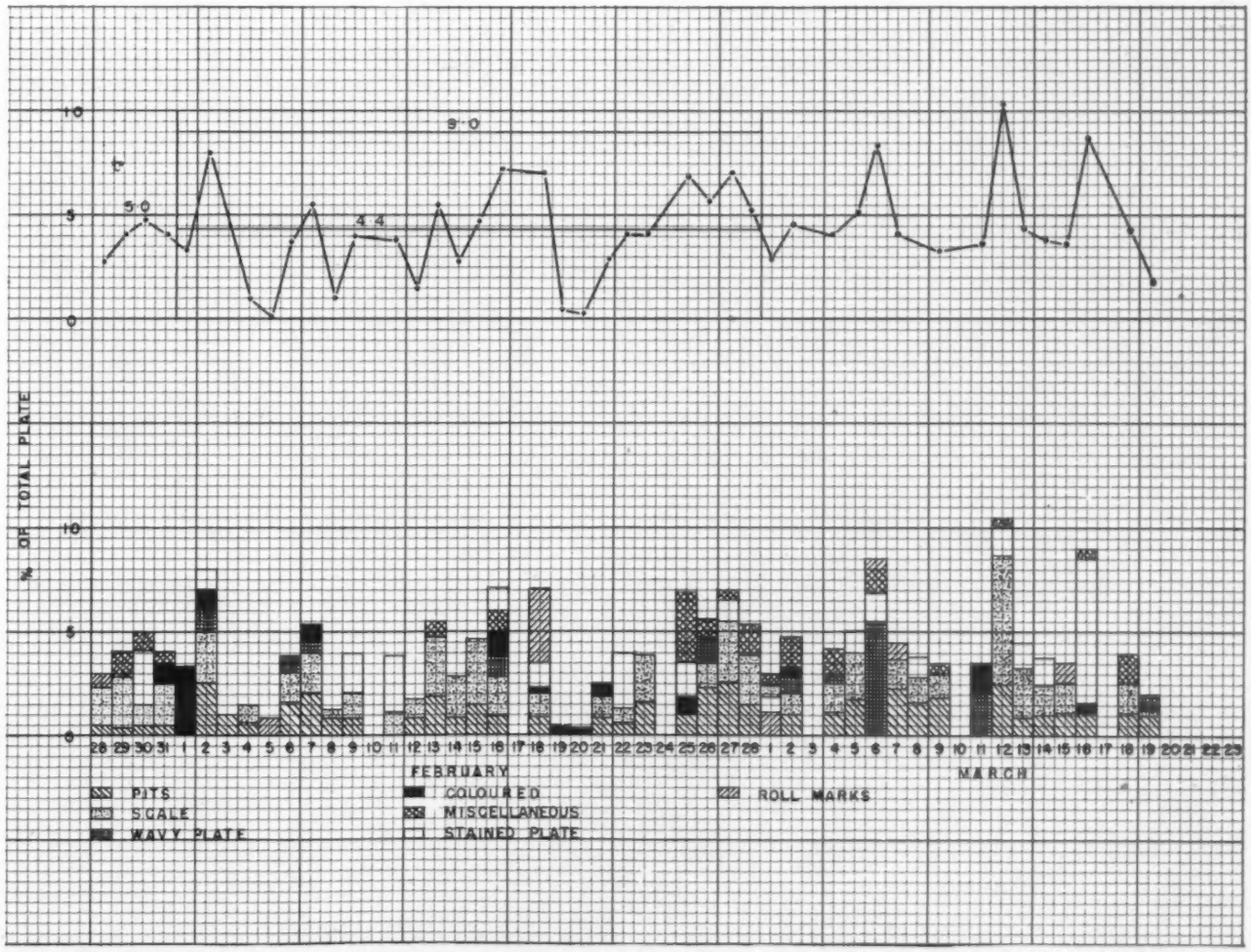

% OF OPERATING TIME
30
20
10
0
1 2 4 5 6 7 8 9 11 12 13 14 15 16 18 19 20 21 22 23 25 26 27 28
FEBRUARY
1 2 4 5 6 7 8 9 10 11 12 15 14 15 16 17 18 19 20 21 23 24 25 26 27 28 29 30 31
MARCH
CHANGE SCRUBBERS
CHANGE RUBBER ROLLS
NO STEEL
BREAKS
COIL STUCK ON REEL
NO CRANE
TIGHTEN SCRUBBERS OR ROLLS

Figure 5 — Chart shows reasons for operating delays shown on the graph in Figure 4.

Figure 6 — This chart shows the seconds found in the sorting room, and also shows the reasons for rejection.



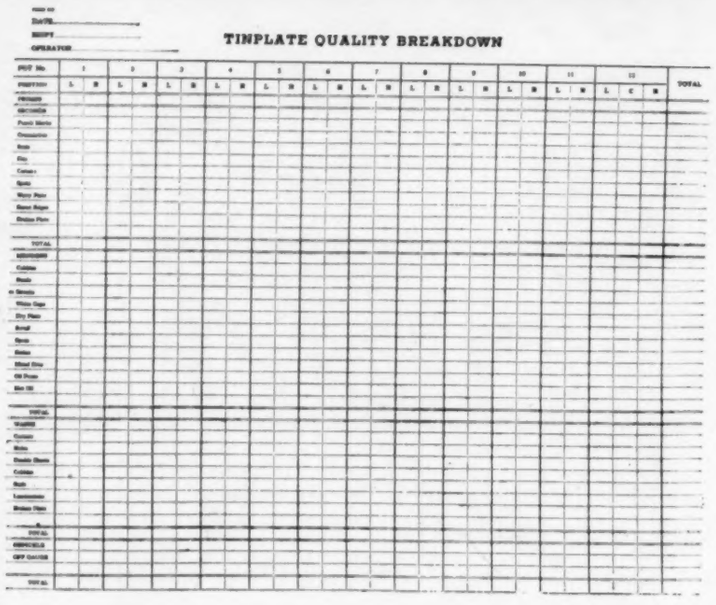


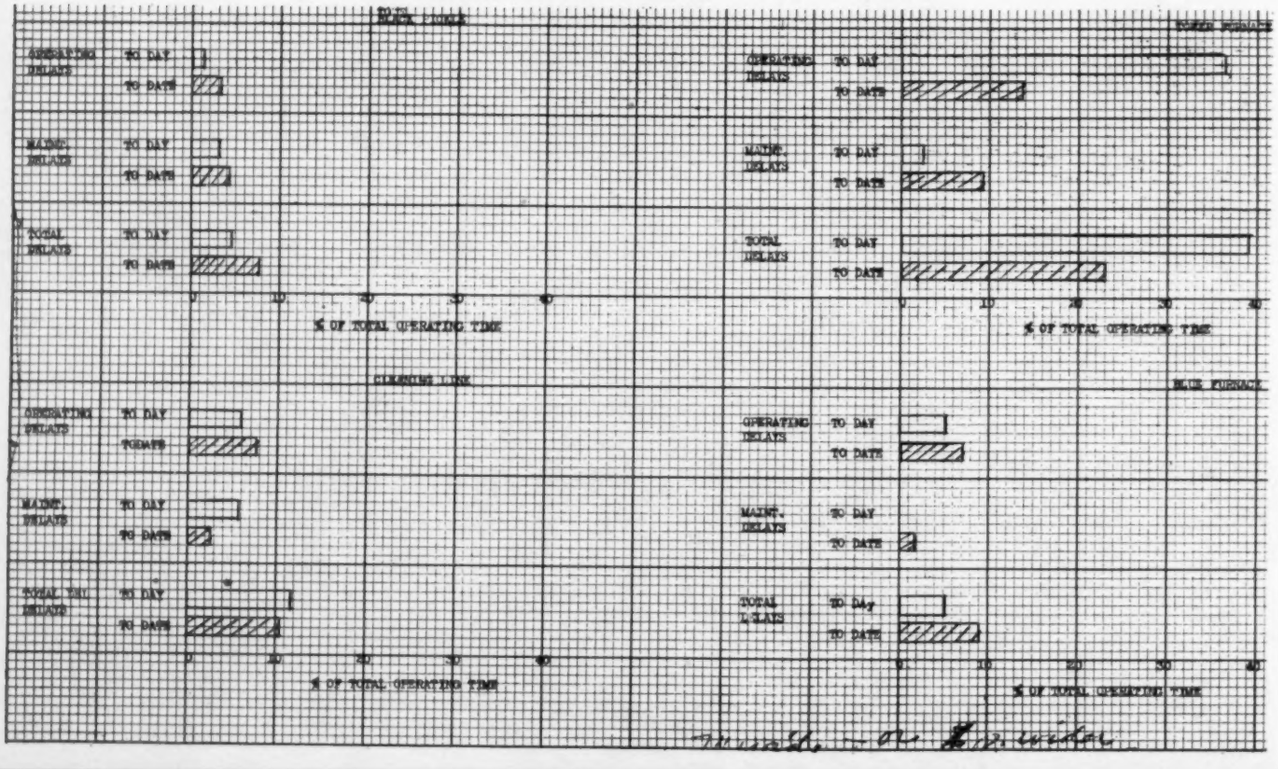
Figure 7 — Inspection form used to tabulate quality rejects.

cannot be over-emphasized and, in fact, in processes which depend largely on human skills, may be more important than the plotting of control charts. To assist this function of the control department all charts are prepared on translucent paper and are in loose-leaf form so that blueprints may be readily prepared and distributed to the operating departments. Daily reports in graphic form and monthly summaries of quality and production levels are prepared for executives and production supervisors. Also, large wall charts are displayed in the tin house showing daily rejections caused by a few major defects. Figure 8 shows the form of the daily delay reports.

Although this control program has been in full operation for only a few months, the benefits are already apparent. The overall quality level of tin plate products has improved by about 25 per cent and many of the individual causes for rejection have been reduced by even greater amounts. The study of process delays is still in the development stage, but improvements in the efficiency of a few critical operatives may already be anticipated.

As the program develops and the various operations are broken down into their component parts, the causes of process variability and product rejections become more apparent. The relationship between many of the operating variables and the defects in the final product must be established by more advanced correlation techniques. The control of surface texture is still in the early stages of investigation and, as yet, it has not been possible to reduce cold rolling and temper mill practice to a statistical basis. These and other problems will necessitate continued study and development, but the basic statistical methods and necessary action procedure have been laid down and their effectiveness established by appreciable quality and production gains.

Figure 8 — A daily form to summarize quantity and location of delays is here illustrated.



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APPENDIX

CONTROL CHARTS FOR MEASURED VARIABLES

The methods used for control chart construction were generally those outlined in the "A.S.T.M. Manual on Presentation of Data" (1), "British Standard BS 1008" (2), "American Standards Association Z-90" (3), and other standard works on statistical quality control. The margin numbers in the appendix indicate references listed at end. In most cases $\bar{x}$ values were plotted (n = 2 or 4 or as daily averages). Control limits were determined by the formula shown which uses the value of range R to avoid the more involved calculation of standard deviation values.

$$\text{Upper control limit} = \bar{\bar{x}} + A_2\bar{R}$$
$$\text{Lower control limit} = \bar{\bar{x}} - A_2\bar{R}$$

where $\bar{\bar{x}}$ = the average of a set of $\bar{x}$ values, i.e., the average of the averages of x values in a series of sample lots.

$\bar{R}$ = average of a set of R (range) values

A_2 = a constant (see A.S.T.M. Manual) (1)

Whenever control of the variable under consideration was largely dependent on the skill of the men involved, control charts were usually plotted for each operating group of the shift using three-color charts.

Range charts were a necessary supplement to $\bar{x}$ charts in many cases, particularly when the daily average values might result from as many as ten readings.

Limits on the range charts were also plotted according to the methods outlined in the A.S.T.M. Manual (1)

$$\text{Upper control limit} = D_4\bar{R}$$
$$\text{Lower control limit} = D_3\bar{R}$$

where $\bar{R}$ = average value of a series of R values

and R = the range or difference between maximum x and minimum x values in any one set of samples.

CONTROL CHARTS FOR ATTRIBUTES

Since many of the operating conditions in steel plants may only be measured by the method of attributes "p" charts are widely used, particularly as a measure of fraction defective in the finished product.

Ordinarily the control chart for "p" is most useful when samples are large (n > 50) and when the expected number of defects per sample is four or more (pn = 4 or more).

Control limits for "p" chart may usually be obtained by the following method:

$$\text{Upper control limit} = \bar{p} + 3\sqrt{\frac{\bar{p}\,(1-\bar{p})}{n}}$$

$$\text{Lower control limit} = \bar{p} - 3\sqrt{\frac{\bar{p}\,(1-\bar{p})}{n}}$$

where $\bar{p}$ is the central line of the chart and equals the average fraction defective in all samples examined during a given period.

Since the underlying distribution upon which "p" charts are based is a bi-nominal, conditions may arise under which this 3-sigma method does not provide workable control limits. Indeed, with very large values of n and small values of p. the great majority of the points may fall outside the control limits. In such cases, a "c" chart or "number defective" may be suitable if the values of n are constant. Limits may also be calculated by using the formula for $\bar{x}$ charts in which case $\bar{R}$ is obtained by averaging the ranges between each successive pair of p values. (4)

If the value of n varies from sample to sample, the control limits should theoretically be calculated for each sample size. However, if the variations in sample size are not great (under 20 per cent), it is generally satisfactory to use the average value of n for the period.

A "p" chart is shown in Figure 6.

CORRELATION AND CONTINGENCY CALCULATIONS

Control charts were found to be invaluable as a means of studying the degree of control of process and product variables. However, it was often necessary to establish the relationship between these variables and the most suitable operating ranges. For this purpose several methods of calculation were used:

1. (a) Single contingency was conveniently determined by means of "scatter plots" or "scatter diagrams."

   If two associated series of values are plotted graphically with one variable placed on the x axis and one on the y axis, the result is known as a scatter diagram. If there is a relationship, the points will follow a definite line of movement or a path and if the relationship is perfect, the points should all fall on a line curve.

   However, such line relationships are rare in steel plants where the quality of the product may be affected by a very large number of variables and where the attributes are at best only moderately accurate due to the variability of human judgment. As a result, such diagrams usually show a high degree of scatter and the degree of association must be determined mathematically rather than visually.

   The degree of association in scatter diagrams may be determined by calculating the value of chi squared according to the general formula shown below:

$$X^2 = \frac{1}{(\epsilon x)\,(\epsilon y)}\left(\frac{(x_1\,\epsilon y - y_1\,\epsilon x)^2}{x_1 + y_1} + \frac{(x_2\,\epsilon y - y_2\,\epsilon x)^2}{x_2 + y_2} + \ldots + \frac{(x_n\,\epsilon y - y_n\,\epsilon x)^2}{x_n + y_n}\right)$$

   The points are divided into approximately equal parts along the y axis by a single horizontal line and into two, three or more approximately equal parts along the x axis by vertical lines, and the resulting areas identified as shown below. The number of

points in each area is then counted and inserted in the formula shown above.

y axis	x_1	x_2	x_3	ϵx	
	y_1	y_2	y_3	ϵy	
	$x_1 + y_1$	$x_2 + y_2$	$x_3 + y_3$	$\epsilon x + \epsilon y$	x axis

From Fisher's tables of the relation for P to chi squared we find the corresponding P value when the degrees of freedom are known (for the above diagram n = 2).

P is the probability number which indicates how often a scatter diagram as biased as the one under investigation would occur by chance.

Values of P below 0.05 may be considered significant, particularly if such values are repeated in subsequent tests of the same variables.

(b) The correlation coefficient is often used to indicate the relative degree of relationship between several variables and the quality of the product. However, the calculation becomes very laborious as the number of results increases.

The general formula is shown below:

$$r = \frac{\epsilon(x - \bar{x}) \quad (y - \bar{y})}{\sqrt{\epsilon(x - \bar{x})^2 \quad (y - \bar{y})^2}}$$

where r = correlation coefficient and
perfect correlation is indicated by value of 1.0, and
no correlation is indicated by value of 0.
x = a reading of one variable
$\bar{x}$ = average of x readings
y = a reading of the other variable
$\bar{y}$ = average of y readings

For details of methods see Simon. (6)

(c) The ratio difference technique as outlined by Simon (6) may be applied to a scatter diagram to give not only some measure of the degree of correlation but also an approximate idea of the operating range which will produce the best quality. The method is easily applied but possesses certain limitations regarding the division of data which should be studied carefully from the text referred to above.

Other methods such as association tables and regression line calculation are discussed in most of the reference texts listed at the conclusion of this paper.

2. Double contingency and multiple correlation techniques have been found increasingly useful in steel plant and foundry control but their application is generally too tedious and difficult for the average control office.

Since the variations in any series of observations are seldom dependent on a single variable, it is often necessary to measure the degree of association between such a series and a number of the variables which might cause these variations. This technique is known as multiple correlation.

The procedure is similar to the calculation of regression lines used in simple correlation but the variables are added successively to the regression equation. Since it is necessary to solve simultaneous equations equal in number to the number of variables under consideration, these calculations will obviously become very complex.

Details of multiple correlation calculations are given by Ezekial (7) and Tippet (6).

In addition to control chart and correlation techniques, methods of estimating the reliability of average values and differences between averages will be found useful. These are described in most texts on statistical methods, see references (4) and (7), and are outlined briefly below.

Let $\bar{x}$ be the average of a series of observations
The standard deviation of the sample

$$\sigma = \sqrt{\frac{\epsilon(\bar{x} - x)^2}{N}}$$ where N = the number of observations

Standard error of average = $\frac{\sigma}{\sqrt{N}}$

The odds are 68 out of 100 that the true average lies between $\bar{x} \pm \frac{\sigma}{\sqrt{N}}$

95 out of 100 between $\bar{x} \pm \frac{2\sigma}{\sqrt{N}}$

99.7 out of 100 between $\bar{x} \pm \frac{3\sigma}{\sqrt{N}}$

The standard error of a difference between two average values may be obtained as follows:

$$\sigma D = \sqrt{\frac{\sigma_1^2}{N_1} \quad \frac{\sigma_2^2}{N_2}}$$

where $\sigma 1$ = standard deviation of first sample
$\sigma 2$ = standard deviation of second sample
N_1 = number of items in first sample
N_2 = number of items in second sample

A difference as large as 3 D might arise by chance in 99.7 cases out of 100, but if the difference is much larger it is unlikely that it would arise due to chance.

A method of calculating the significance of quality difference between two samples is outlined in "Applied General Statistics" by Croxton and Cowden (7) and by Tippet (6) which may be found useful in steel plant control. However, this method should be applied to the comparison of "fraction defective" with caution since it assumes that the distributions of both samples and the difference in the values of "p" are approximately normal.

These conditions are only realized for a bi-nomial distribution when p ranges from 0.10 to 0.50 and the sample size N is greater than 50.

The following example shows the application of this method to two groups of cold rolled coils produced under different operating conditions.

"A" Group	"B" Group
15 rejected 150 inspected 0.10 fraction defective (p)	20 rejected 150 inspected 0.133 fraction defective

$$\text{Standard error of } p = \sqrt{\frac{p \times a}{N}} = \sigma\, p$$

where p = fraction defective
a = fraction effective (or 1 − p)

For "A" group

$$p = \sqrt{\frac{0.10 \times 0.90}{150}} = \sqrt{\frac{.09}{150}} = \sqrt{.0006}$$

$$= 0.078$$

The odds are 95 out of 100 that the true fraction defective for this group lies between —

$$p + 2\sigma p = 0.10 + 0.078 = 0.178$$

and $p - 2\sigma p = 0.022$

and from this sample from 3 to 27 rejects might normally be expected. Similarly, for "B" group σp is 0.088 and from 7 to 33 rejects might normally be expected.

The significance of the difference between groups may be determined as follows:

$$t = \frac{pA - pB}{\sigma\,(pA - pB)} \qquad \frac{pA - pB}{\sqrt{\sigma\, pA^2 + \sigma\, pB^2}}$$

where t = ratio between the observed difference and the standard error of the difference

$$\text{In this case } t = \frac{0.033}{\sqrt{0.0137}} = \frac{0.033}{0.117} = 0.28$$

The 0.05 level of significance for t is 1.96 so that if t is less than 2.0 the difference between the values of p for these groups has little meaning.

MOHLER DISCUSSION

(*Continued from page 66*)

galvanizing line, I would like to say that this is a process line for continuously heating and galvanizing strip at something like 100 fpm. This line uses a combination of high frequency and resistor type heating.

Mr. Angel made the remark that he would like to see control equipment developed which would take up less space and stand considerable punishment. In connection with this, all I can say, it is also our sincere desire to accomplish this very purpose, and I can tell you that we are going through the experimental stages right now of developing such equipment.

Mr. Miller asked the question as to whether the metallurgy of the material to be measured affects the accuracy of the X-ray thickness gauge or not. A variation in the metallurgy which would cause a material change in the atomic weight would affect the accuracy. However, if the metallurgy of the strip is universal, the variation in atomic weight can be compensated.

J. JAY DUNN

(*Continued from page 57*)

maintenance of the standards set. Up to the first of the year, 561 collapse tests were recorded on the product. The coefficient of variation for the entire number was 6.79 per cent.

It is probable that this coefficient is somewhat high, as it was observed to decrease gradually as the data were accumulated.

The test results expressed in terms of equation (11) with n=3 are

$$P = (1 \pm 0.204)\,\frac{252{,}566}{D/t} - 5622 \qquad (13)$$

As the dimensions of the pipe were mainly in the plastic stress range, the constants for equation (12) have not been determined. The question here is the experimental values for Young's and Poisson's constants.

It should be obvious that the process has great flexibility. By varying the chemistry, temperature and amount of reduction, grades of higher or lower collapse resistance are produced.

In concluding this review of the effort made to find a solution of the economic problem presented by the drilling of deep wells as it relates to the resistance of pipe to external pressure, the hope is expressed that omission of the major portion of the many contributions made to the subject may not detract too seriously from the purpose of directing attention to the value of careful planning of an experimental investigation. The mathematical solution of the problem of unstable equilibrium preceeded Stewart's experimental investigation. Today, the application of statistical methods for planning experimental work and evaluating the test results are too frequently neglected. Hit and miss methods may ultimately secure results. Some of it is necessary, but it is both time-consuming and costly.

Plan to Attend...

THE **AISE** CONVENTION AND IRON AND STEEL EXPOSITION

▲

CLEVELAND PUBLIC AUDITORIUM
CLEVELAND, OHIO

▲

October 1, 2, 3 and 4, 1946

▲

Details will be announced soon.

The Treatment of Waste Waters

FROM THE STEEL INDUSTRY

. . . . the increasing concern with which public authorities view the stream pollution problem will eventually force many mills to review their practices of waste water disposal . . . .

by Christian L. Siebert

CONSULTING SANITARY ENGINEER

CAMP HILL, PENNSYLVANIA

▲ THE day of reckoning appears to have come. The insistent demands of the public, headed by conservationists and sportsmen, have finally brought about a general acceptance of the principle that pollution of streams by industrial wastes, as well as pollution by domestic sewage, must be controlled. Even the public press, which has heretofore been generally cold or lukewarm to the campaign of conservationists, has almost unanimously become editorially aggressive in championing the cause of clean streams. Party politics has taken a back seat in this movement since both major parties have acceded to the public demand in supporting measures to prevent harmful pollution. The movement cannot be interpreted as capricious and likely to fade with the counter-swing of the pendulum, since it bears the earmarks of a "fait accompli" which needs only the consolidation of its gains to result in practically nation-wide adoption of reasonably uniform regulations.

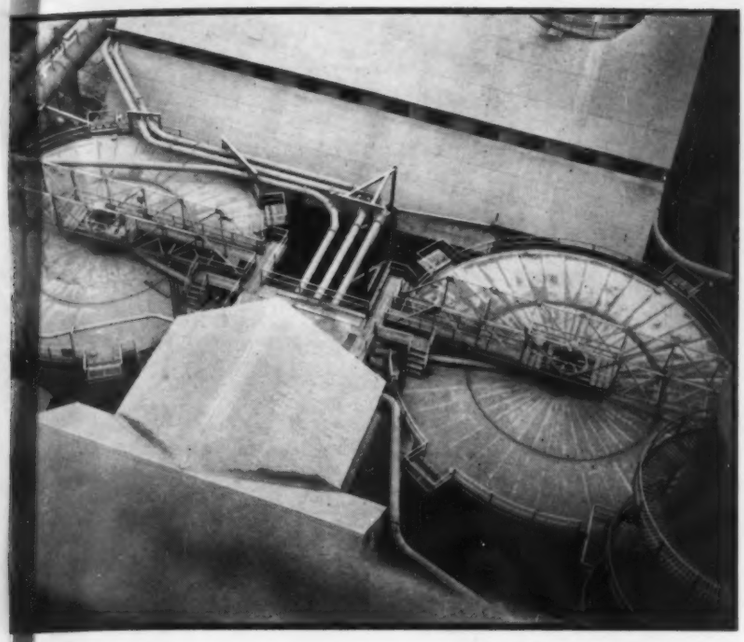
Pennsylvania has set the pace with its new laws and positive administrative policy for the control of stream pollution. Other states have definitely strengthened their stand and all signs point to the adoption of Federal regulations based on one or another of a number of bills now pending before Congress.

Methods for treating domestic sewage have become fairly well conventionalized in recent years and results to be attained by any given type of treatment works, if properly designed, can be closely predicted. However, the treatment of industrial wastes is a much more complicated problem. Domestic sewage from municipal systems averages pretty nearly 100 gallons per capita per day in volume, is normally alkaline, contains about 300 parts per million of suspended solids and has a 5-day biochemical oxygen demand (decayability) of, roughly, 200 parts per million. These factors control the design of treatment works, subject to relatively slight variations due to local conditions. However, industrial wastes are "as you find them." They may be highly alkaline or strongly acid, heavy in suspended solids or almost devoid thereof, highly colored or water white, toxic or of wholesome food value, have biochemical oxygen demand (BOD) of zero or as high as 60,000 ppm, and they may vary in quantity from only a few gallons to thousands of gallons per employee. Furthermore, two establishments manufacturing like quantities of the same product may discharge waste waters differing widely in volume and analytical characteristics.

Obviously, a careful survey is necessary to determine volumes and analytical characteristics before conclusions can be reached on methods of treating industrial wastes. When the facts have been established as applicable to both present and probable future conditions, thought may be given to the type of treatment works, its location with respect to available sites and convenience in operation, materials of construction, and other details.

The most common wastes produced in the iron and steel industry are acid pickling liquor, plating solutions, blast furnace dust, oils (both lubricating and quench), cutting compounds and phenols. None of these except some of the cutting compounds, are high in decomposible organic matter, as are waste waters from tanneries, paper mills, distilleries, canneries, milk plants, textile mills and meat packing plants. Neither are the metallurgical wastes as high in suspended solids as are the washery wastes of the anthracite industry which have blackened and silted many of our Eastern streams.

Presented before AISE Philadelphia District Section Meeting, December 1, 1945.



The 60 foot diameter by 38 feet high twin unit Dorr thickener shown removes 99.8 per cent of settleable solids from the blast furnace gas scrubber water.

However, the pollutional characteristics of the metallurgical wastes are nevertheless objectionable and require treatment specifically designed for each type of waste.

ACID PICKLING WASTES

Undoubtedly, the waste water most frequently the cause of complaint in the iron and steel industry is acid pickling liquor. From the small tack factory to the largest tube or strip mill, the disposal of pickle liquor is a problem. Acid solutions used for pickling ferrous metals are usually wasted when their acid content becomes reduced to about 2 to 4 per cent but it may be surprising to realize that 85 to 95 per cent of the acid and metals are lost in the dilute wash waters and only 10 to 15 per cent in spent pickle liquor. The acid effect of pickling plant wastes on receiving streams is due not only to free acid but also to the acid formed by hydrolysis of the iron salts in solution. Furthermore, the copperas (ferrous sulphate) in the wastes has a great demand for oxygen. Such discharges not only reduce or overcome natural alkalinity and impose a heavy oxygen demand but they also increase hardness of the water, so causing difficulties and expense in water treatment as well as harm to fish life and, sometimes, destruction of metal and concrete structures.

Acid pickling liquor cannot safely be admitted to public sewer systems or sewage treatment works because of resultant disintegration of steel and concrete, compacting of sludge, clogging of trickling filters, disturbance of reaction in activated sludge systems and clogging of air diffusers.

Conservation in use of acid not only reduces the cost of the pickling process, but minimizes the pollution control problem. It is usually possible to effect marked savings in acid by providing thorough drainage of the metal back into the pickle tank before immersion in the rinse tank. In tubing mills, it is important that tubes be tilted and held for thorough drainage. Some strip mills which operate continuous pickling have squeegee rolls to remove acid as the strip leaves the pickle tank. Air nozzles or jets of steam or water mist can also be used to blow excess acid back into the pickle tank as rods or strips are passing out. Also, it is probable that many mills could profitably adopt more modern methods of metal cleaning than still pickling, with its extravagant waste of acid, but the inertia of habit is difficult to overcome.

At some steel works, spent pickling liquors are treated by addition of scrap steel to exhaust the free acid, followed by evaporation and drying of the residue to produce commercial copperas or ferrous sulphate. The limited market for ferrous sulphate prevents wider adoption of this reclamation process.

Many works neutralize the pickle liquor with lime, followed by aeration and sedimentation to complete the reaction and remove the iron oxides and salts, so eliminating free acid and minimizing iron and hardness in the effluent. In some instances it may be necessary to filter the alkalized and settled wastes through sand for removal of remaining hydrate floc or oxide.

Variations and refinements in the basic principle of neutralization and sedimentation have been developed but, as yet, have not established their economic practicability. One of the proposed methods utilizes fine limestone, crushed in a wet ball mill, for neutralization of all waste acid and hydrolizable iron compounds by three-stage agitation and aeration for completion of reaction. The slurry so produced is recirculated at an adjustable rate, through the agitator compartments, for building up large particles of calcium sulphate and ferric hydroxide which will filter readily. The effluent from the agitator battery passes to a flocculator where a small quantity of starch is added to assist in clarification, after which the liquid passes through a clarifier tank. Settled solids from the clarifier are dewatered on a vacuum filter to a firm cake suitable for final disposal. The promoters of this process claimed that it would produce an effluent substantially clear, alkaline to methyl orange, of pH about 6, containing not over one pound of insoluble suspended matter per thousand gallons, with 98 per cent removal of ferrous sulphate and at least 98 per cent oxidation of ferrous iron. It is reported that actual performance of this complicated process in a large scale pilot plant proved only 85 per cent efficient. Another method which has been experimentally exploited is the "Ferron Process" which provides for excess treatment with unsilicated low magnesium lime, heating and agitation, and treatment of the resultant slurry in a filter press for extraction of the mixture of calcium sulphate (gypsum) and iron oxide which is extruded from a pug mill in blocks. The blocks of reclaimed material are dried and made available for conversion into insulating and construction materials such as pipe covering, partition block and wall board. The liquid effluent is clear, colorless and free of acid with a pH of approximately 7.5. Unfortunately, the

abundance of other and cheaper insulating and construction materials has, so far, prevented this process from becoming economically successful.

Description of these two rather complicated methods of treatment is given to emphasize the difficulties faced in the economical treatment of spent pickling liquor and the efforts which have been made to solve the problem.

Undoubtedly the most intensive effort to develop a practical method for treatment of spent pickling liquor is that of the research foundation established at the Mellon Institute of Industrial Research, Pittsburgh by the American Iron and Steel Institute. So far, the published reports of the exhaustive studies of this project do not offer any treatment more practical and economical than neutralization of acid with lime or limestone, supplemented by aeration to completely oxidize and permit removal of iron. However, this research has contributed much valuable information on the most effective and economical details of treatment. Of particular interest is the limestone-lime split treatment in which finely pulverized high calcium limestone is used to neutralize free acid and precipitate part of the iron, while lime is used in a second stage to complete the reaction. Substantial economy is claimed for this split treatment, particularly in cases where the large volumes treated justify the added complication.

Heretofore, insufficient consideration has generally been given to the kind of lime used for neutralization. The basicity factor of the lime is of very real importance from an economic standpoint as the quantities of lime used are considerable. High calcium limes have been more commonly used for this purpose but there are conditions under which the use of dolomitic (high magnesium) lime would prove distinctly economical in purchase cost, as well as due to reduction in volume of the calcium sulphate sludge produced, provided there were no particular objection to the increased hardness imparted to the water of the receiving stream by the soluble magnesium sulphate. However, some refinement in control tests is necessary if proper advantage is to be taken of the economies made possible with dolomitic lime.

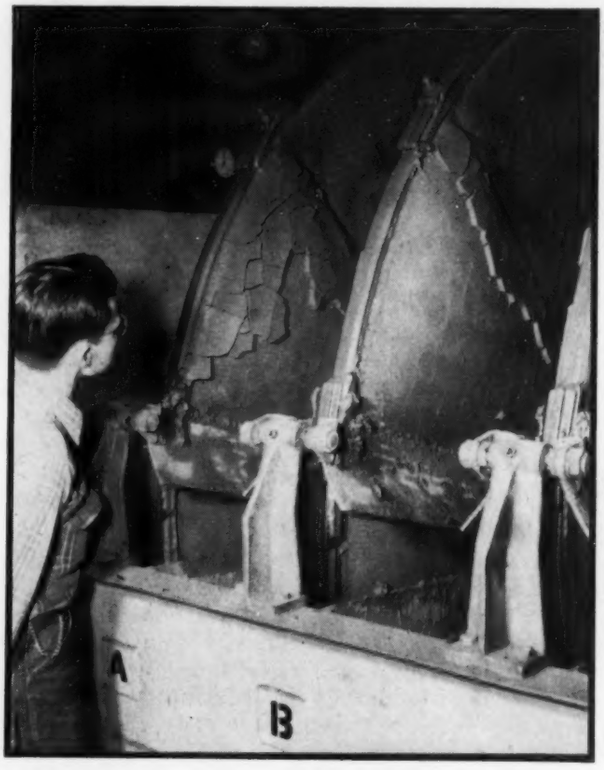
PLATING AND HEAT TREATMENT WASTES

Cyanide wastes are discharged from plating rooms in spent plating solutions, rinse waters and spillage. Some cyanide is also wasted in heat-treatment processes, and it should be detoxified in a manner similar to that applied to plating wastes unless carefully collected and disposed of where it cannot wash to streams, poison nearby well waters or otherwise endanger humans or animals.

Average plating rinse waters contain about 100 ppm cyanides. A typical spoiled cyanide bath contains about 15,000 ppm cyanides plus other harmful matter. From 0.5 to 2.0 ppm cyanides will kill fish in a short time, will destroy the food of fish and may also be harmful to man in relatively small quantities. Obviously, cyanide wastes should not be discharged without adequate treatment into any public waters or to the ground in the vicinity of wells.

Ponding has been successful in treating cyanide wastes as such storage ultimately results in destruction of the toxic cyanide by oxidation, hydrolysis or decomposition. However, ponding requires large areas which are rarely available and, also, presents the danger of poisoning nearby ground water sources or harming persons or animals coming in contact with the deposit.

Treatment of cyanide wastes with acid is successfully practiced in some large establishments. The wastes are accumulated in a tank provided with a tight hood leading to a stack with forced ventilation. Sufficient acid is added to complete the reaction whereby the cyanides are converted to hydrocyanic acid gas which pass to the atmosphere from the stack. Air agitation is provided in the bottom of the tank to assist the process. The treatment works must be located and designed to minimize danger to attendants and others in the neighborhood from the highly poisonous gases released and the acid must be added slowly to prevent excessively rapid production of hydrocyanic acid. The batch treatment requires about 16 hours and careful tests are required to indicate when the treated solution is practically free of the poisonous cyandies (less than 1 ppm) and ready for discharge or for subsequent alkaline treatment to neutralize residual acid which may not be acceptable in the receiving stream.



Illustrated here is vacuum filtration of the blast furnace scrubber water settled slurry.

Other methods now practiced to destroy the toxicity of cyanides are treatment with ferrous sulphate (copperas or spent pickle liquor) to produce ferro-cyanides and treatment with lime-sulphur (agricultural spray

material) to produce thiocyanate, both the ferro cyanide and the thiocyanate being practically non-toxic. Treatment with chlorine to completely break down the cyanogen has been successfully adopted in at least one full scale operation. Experience appears to indicate that any of these processes can be made fully successful, with careful control, and the ferrous sulphate method is particularly attractive if spent pickle liquor is always available when plating wastes are produced. Obviously, the use of spent pickle liquor to treat cyanide wastes does not eliminate the necessity of neutralizing acidity and removing oxidizable iron.

Removal of chromium from plating wastes presents a rather difficult problem because this metal is mostly present in the chromic form and must be reduced to the chromate before it can be precipitated with conventional lime treatment. Barium sulphide has been used to directly precipitate some of the hexavalent chromium as barium chromate with the sulphide acting as a reducing agent on the remaining chromate for precipitation with lime. Other chemicals may be employed to remove chromium but it appears that particularly careful control is necessary to secure satisfactory results with any known treatment process.

Of the samples of blast furnace scrubber water, the two on the left are taken just before the water enters the thickener, and has settleable solids of 275 to 300 grains per gallon; the next four are taken from the thickener effluent and have settleable solids of 0.2 to 0.7 grains per gallon; and the seventh sample is river water from the pump house intake with settleable solids of 0.75 grains per gallon.

BLAST FURNACE DUST

Until rather recently it has been common practice to discharge blast furnace gas washer waste water without treatment. This frequently resulted in heavy accumulations of solids in the bed of the receiving stream and objectionable turbidity in the water of the stream. The dust ordinarily contains about 50 per cent iron and, obviously, much valuable material has been thrown away.

At many blast furnaces, the gas scrubber water is now settled in thickeners or clarifiers, commonly of the radial flow type with rotating mechanical sludge removal mechanism. The sludge or slurry is generally pumped to ore storage piles or hoppers where the water drains away and leaves the iron-bearing dust adhering to the ore so that it can be recharged to the blast furnace. Although the fine dust may again be blown out of the furnace with the gas, this recycling process is reportedly satisfactory in a number of instances.

At one large mill where seven blast furnaces are operated, the gas scrubber water, about 15,000,000 gallons per day in volume and containing about 270 grains per gallon of suspended solids, is treated in two large clarifiers of the radial flow multiple tray type. The theoretical detention period is about two hours. The slurry removed is reduced to about 25 per cent water on vacuum filters and is then prepared for recharging to the blast furnaces in a form which will produce a minimum of dust in the furnace gas. The clarified water normally appears quite clear, containing only about 0.5 grain per gallon of suspended solids (over 99 per cent efficiency) and may be used again in the gas scrubbers or discharged to waste. It has been estimated that this installation, which cost about $485,000, recovers at least 320 tons (dry basis) of flue dirt daily valued at $5.80 per ton or $1750 per day which makes a total recovery valued at $625,000 per year.

Mention may also be made of the scrubber wastes from producer gas plants as these may contain sufficient hydrogen sulphide to cause damage to fish and aquatic life. As little as 1 ppm of hydrogen sulphide in water is lethal to trout. It may be necessary to aerate, settle and recirculate producer gas scrubber water to prevent harmful pollution. Obviously, it is advantageous to use only low sulphur coal in gas producers.

OIL WASTES

Practically every establishment engaged in the manufacture or processing of iron or steel uses considerable quantities of oil for lubricating purposes. When lubricating oil is wasted from rolling mills, power units, machine tools, etc., it is usually so dirty and mixed with water or lubricants of various grades that it can not be reused for specific lubricating purposes without first being reconditioned. Often the quantity of waste oil is not sufficient to be considered economically reclaimable by the mill management and, consequently, the nearest stream becomes a convenient channel of disposal with resultant destruction of fish and other aquatic life, as well as accumulations of floating oil masses which are not only unsightly but may constitute definite fire hazards. Only 50 to 100 gallons of oil is required to produce a visible film over one square mile of water surface.

The use of separate sewers for conveying oil-bearing waste waters is important, because by segregation the

volume of waste water requiring treatment can be reduced and the cost of waste treatment can be minimized by providing treatment units of only sufficient size to handle the oil-bearing wastes, without addition of roof water, cooling water or boiler wastes which are large in volume and would flood an otherwise suitable treatment unit.

The conventional method of removing oil from waste waters is by a gravity flotation separator. A satisfactory separator for most of the oils wasted from iron and steel mills would provide a detention period of not less than 60 minutes, with velocity in flow not exceeding 2 feet per minute in the main body of the separator and 4 feet per minute partition velocity under baffles. Length of a separator is usually 2 to 3 times its width and the working depth not over about 6 to 8 feet. Baffles of simple separators should be limited to one underflow baffle near the influent end and one near the effluent end. Positive means should be provided for frequently removing not only floating oil but also settled solids. Manual skimming may suffice for very small installations where little oil is accumulated but specially designed skimming pipes connected with pumps and oil reservoirs are usually necessary and good investments. For the kinds of lubricating oil usually discharged from iron and steel works, a properly designed simple separator should produce an effluent containing less than 30 parts per million of oil and the quantity and value of oil reclaimed is often surprising.

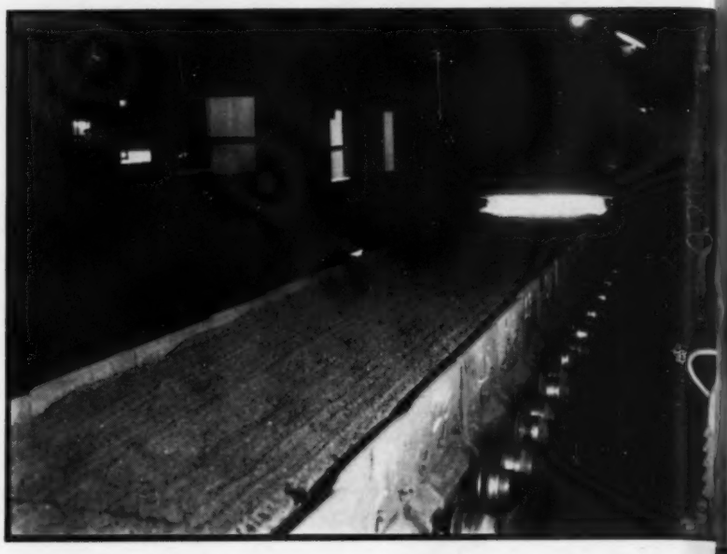
Where large volumes of oil-bearing wastes must be treated, and particularly if some of the oils are not easily separable and the waste waters also contain suspended solids, a more complicated separator design is sometimes necessary. A manual of separator design called "Disposal of Refinery Wastes," dealing with the theory and the practical application of principles has been prepared by the American Petroleum Institute, and may be bought from the API New York office.

In the past, some plants charged the same quench tanks intermittently with water and oil, with the result that much oil was lost when quench water was wasted. Obviously, this is bad practice and is inexcusable from an economical standpoint, let alone from the standpoint of the resultant unnecessary stream pollution.

Emulsions of oil cannot be removed by an ordinary separator and oils of different specific gravity behave differently. Excessive alkalinity or acidity of liquid medium, as well as temperature, are also important factors to be considered. In general, careful and intelligent study of oil wastes should be made before a separator is designed and the designer should be thoroughly familiar with modern principles of oil separation.

CUTTING COMPOUNDS

Most cutting compounds are emulsions of oil and these emulsions break to release oil when diluted or their reaction is sufficiently changed in the receiving stream. Furthermore, the vegetable oils and soaps often used in these compounds are subject to biological decomposition which imposes a substantial oxygen demand on the receiving body of water. Reconditioning and reutilization of cutting compounds is generally practiced but, nevertheless, some of the material is usually wasted.



The sintering flue dust was recovered from blast furnace gas. ↑

A large installation of the Mantius process for recovery of sulfuric acid and ferrous sulfate from waste liquors is here shown. →

Acid cracking and chemical coagulation, under carefully controlled conditions, is often successful in effectively treating these wastes and such treatment has been reported as capable of reducing by about 95 per cent the oxygen consuming material which may be as high as 10,000 ppm. However, careful laboratory study is necessary in each case to formulate a method of treatment specifically applicable to the particular compound in question.

PHENOLS

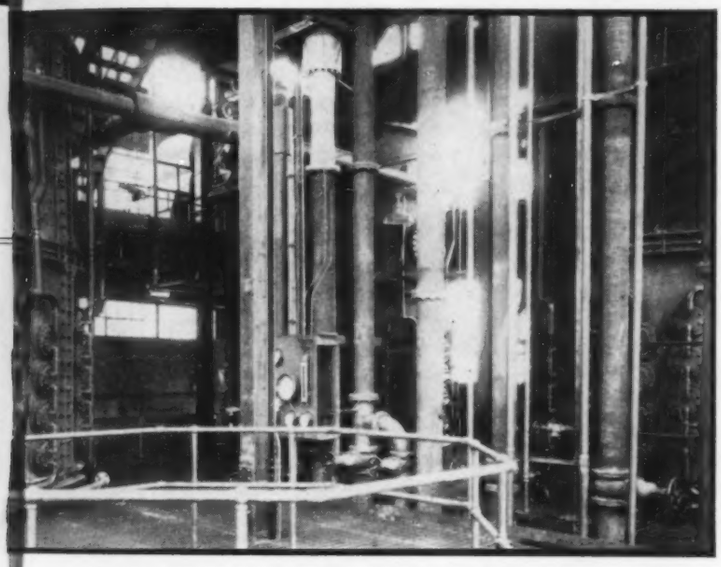
It may not be entirely appropriate in this discussion to include mention of phenolic and associated wastes because such materials originate principally in by-product coke works and their treatment or control is a highly specialized subject which is usually assigned to exploiters of commercialized coking processes. However, the coking industry is almost always a part of or closely related to a steel works and its pollutional effects should be understood. As little as 0.1 ppm of phenol in water is identifiable to taste by some persons and chlorination of phenols intensifies the taste so that concentrations of the chlorinated phenols as low as 1 part in 50,000,000 parts of water produce the well known drug store flavor present in some public water supplies. Also, concentrations of phenolic materials of 5 to 20 ppm are definitely toxic to fish and aquatic life.

The three methods in common use for removal and recovery of phenols from coke plant ammonia liquors

are: (a) steam distillation, (b) solvent extraction, and (c) adsorption by activated carbon.

In the steam distillation process, the ammonia still wastes are sprayed to the top of contact towers and steam is blown upward through the tower. The vapors from the top of the tower are then washed in a caustic soda solution to produce sodium phenolate which is treated with flue gas (CO_2) to neutralize the alkali, and liberate the phenols which are recovered from the aqueous solution by gravity separation. Well designed and operated plants of this type can be expected to produce an effluent containing about 100 ppm of phenols which is about 95 per cent removal efficiency.

The solvent extraction process passes benzol upward through contact towers in which ammonia liquor (previous to distillation) passes downward. The phenols are absorbed in the benzol which is then washed with caustic soda solution to produce sodium phenolate



which is converted to phenol and sodium sulphate upon addition of sulphuric acid. The phenol is removed by gravity separation and the sodium sulfate solution wasted. This process is ordinarily at least 97 per cent efficient in removal of phenols.

The process involving adsorption by activated carbon is new in practical application but gives promise of wide application and high efficiency in phenol removal. In this process, the ammonia liquor, after filtration for removal of most tarry material, but before distillation, is passed through activated carbon filters or adsorbers for accumulation of the phenols in the carbon. These adsorbers are backwashed intermittently with benzol to remove the phenols and the benzol is then distilled off for reuse, leaving the phenols as still "bottoms." The dephenolized ammonia liquor leaving the adsorbers is treated with lime and then passes to conventional ammonia stills. This process is claimed to reduce phenolic content of waste waters to 15 ppm which is a higher efficiency than heretofore attained by other processes.

It need hardly be mentioned that coke quench waters or acid wash waters from by-product coke plants should not be discharged to streams.

CONCLUSION

This paper does not pretend to be a comprehensive manual on the treatment of waste waters of the iron and steel industry. It is merely an outline of the general principles of the subject which may be helpful in establishing the proper attitude for engineers to whom are assigned the solution of the industry's pollution control problem. The importance of first evaluating any specific waste treatment problem cannot be overemphasized and it should be obvious that careful and painstaking laboratory studies, sometimes with pilot plant operations, are usually necessary before actual design of treatment works can be undertaken.

It seems proper to mention here that, in most states, it is necessary to secure approval of plans by a governmental control agency before beginning construction of industrial waste treatment works, and unless the plans and reports submitted are clear and convincing the project is not likely to be approved.

Finally, the most intelligent conception, design and construction of waste treatment works does not assure satisfactory performance. Too often an expensive installation is tuned up to perfection and then handed over for operation and maintenance to some unqualified subordinate who may permit abuse of valuable equipment, fail to practice sensible economies or, through ignorance or indifference, permit the discharge of ineffectively treated waste waters. Also, increase of discharges beyond designed capacity or the addition of new wastes may defeat the purpose of the treatment works. Improper discharges will, sooner or later, come to the attention of the governmental control agency and, regardless of any permit on which the operation of the treatment works may be based, the confidence of the governmental agency is destroyed and the responsible management may find itself in a very uncomfortable position with the possibility that the cost of correction may be much greater than if intelligent and responsible supervision had prevailed from the beginning.

DISCUSSION

PRESENTED BY

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ROY F. WESTON, Sanitary Engineer, The Atlantic Refining Company, Philadelphia, Pennsylvania

W. P. HILL, Assistant Superintendent, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Baltimore, Maryland

F. C. SCHOEN, Plant Engineer, The Midvale Company, Nicetown, Philadelphia, Pennsylvania
C. S. CASSELS, Engineer, Henry Disston and Sons, Inc., Philadelphia, Pennsylvania
C. L. SIEBERT, Consulting Sanitary Engineer, Camp Hill, Pennsylvania

Richard D. Hoak: The comments that I shall make will be confined to waste pickle liquor treatment because practically all of our time at Mellon Institute has been devoted to this very onerous problem. Pickle liquor treatment has been a difficult problem for some 70 years. The program established by the American Iron and Steel Institute has been the first concerted attack on the problem by the industry as a whole, but many individual units of the industry have spent considerable sums of money conducting their own research programs on the problem.

Mr. Siebert mentioned several of the more important processes for dealing with waste pickle liquor. A great many processes have been proposed; many of them have been patented, but on the whole almost none has ever been found to be commercially successful. To those who are interested, I will be glad to send reprints of the Fellowship publications which we have on hand, one paper in particular will give you the most comprehensive discussion of the various treatments that, to our knowledge, has ever been prepared.

The discharge of untreated waste water is, in general, objectionable. There are cases, particularly in the treatment of sewage by chemical precipitation, where, if the free acid is first neutralized, the ferrous sulphate has been found to aid materially in coagulation of the sewage. There is a disadvantage in that the sludge drying capacity of the treatment plant may not be large enough to handle the additional burden if a large quantity of pickle liquor is to be discharged in the sewer system.

The activated sludge process of sewage treatment is adversely affected by pickle liquor. A concentration of iron in sewage in excess of 7 parts per million is enough to cause clogging of the diffuser plates in the aeration chambers, and that necessitates shutting down the plant, taking out the porous plates, and boiling them with acid. That is an expensive operation.

The Ferron Process that Mr. Siebert mentioned was never completely developed because the war intervened before certain difficulties could be overcome. I have recently been in touch with the Allied Development Company of Cleveland, which was responsible for the evolution of that process, and they are anxious to resume their research on it. Their prior calculations indicated that if Ferron could be made on a sufficiently large scale, it could be manufactured at a price which would be competitive with other similar products on the market. My own feeling is that the Ferron process has considerable potentiality. It has the drawback that in order properly to introduce a material of that type, it would be necessary to manufacture it on quite a large scale initially, and it would almost certainly have to have the backing of one of the building material manufacturing companies which has the proper sales outlets for introducing the product. Such a development would involve the expenditure of a very large sum of money. It is entirely possible that something productive will come out of that type of process, and two of the largest manufacturers of building materials in the country were very much interested in it before development work had to be suspended because of a lack of manpower.

The production of copperas from pickle liquor is a relatively simple operation. The difficulty is that the steel industry could produce approximately 20 times the annual consumption of copperas in this country, if all of the sulphuric acid liquor were processed to recover that compound.

A great many people have studied processes for recovery of the free acid in pickle liquor. Re-use of recovered acid has not had the approval of pickling foremen because a number of years ago a plant was installed on a temporary basis to see whether the recovered acid could be so used. As it turned out, the sheets which were pickled in a combination of fresh and recovered acid were badly stained and pickling foremen have been hesitant to consider installing any process which employed recovery of the free acid for re-use in their plants.

In one of our projects, we developed a process for recovering free acid by a novel scheme upon which the Fellowship has received a patent. It has been demonstrated, to the satisfaction of several pickling experts, that the recovered acid obtained from that process can be used successfully when made up to strength with fresh acid. It is quite possible that the use of recovered acid in the picklers may be accepted in the future.

Our research at Mellon Institute has evolved about half a dozen processes which appear to be novel and seem to show some potentiality in this rather difficult field. Unfortunately, the war has not permitted us to study any of these processes on a pilot plant scale, and we are not confident of any economic evaluation we might make as a result of our laboratory studies. We hope it will be possible, in the not too distant future, to investigate them on a pilot plant basis, so that we can present actual economic data on them.

Cyanide wastes can be successfully treated with chlorine, which decomposes the cyanides and produces an unobjectionable effluent. If you are interested in that treatment, you might write to the Chlorine Institute in New York for definite data.

Some steel companies use waste water containing a high concentration of phenols to quench coke. Where the coke is used in blast furnaces, it works satisfactorily but in cases where part of the coke is sold for domestic consumption, the odor accompanying the coke is objectionable.

C. J. Lewis: I believe that spent pickling acids present one of the greatest disposal problems, not only to the large steel industry, but especially so to the smaller industry with from anywhere from 100 to 3000 gallons of waste pickling acids per day. In the first place, there is no sound economic process known for the disposal of waste pickling acids in the United States. If there is any such process I would certainly like to know about it. In isolated cases, waste pickling acids are being successfully disposed of. In one or two cases, the waste acid is taken by a local chemical concern and used in chemical processes, probably for the recovery

of iron as a pigment and for the recovery of the sulfate material for some other chemical purpose. If the industry happens to have ammonia, as part of the unit operation, ammonia can be applied to the waste pickling acid. But most of the industries have no ammonia; they are not located near a chemical concern which can assimilate the waste acid, and so they are confronted with the problem.

During the three years I worked on the problem, associated with Mr. Hoak at the Mellon Institute, I reached the conclusion, (and I believe others share the conclusion with me), that lime treatment of the waste acid offers the only method today, which can be applied with any degree of success. Whether or not the use of lime will be a stopgap method, or whether the use of lime will become the method, remains to be seen.

In dealing with the problem of lime, which lime to use, how it should be used, etc., I make the over-all suggestion that you guard against the erection of any monumental type of treating unit. The lime-treating unit can be made very simple and can be operated as such at a reasonably low cost. Usually the larger part of the cost of operating a lime neutralizing unit is the cost of the lime itself.

If you had in the neighborhood of five thousand gallons of waste sulphuric acid pickling liquor per day, the cost of a lime treating unit to take care of the five thousand gallons would be somewhere between 15 and 20 thousand dollars for the equipment. The cost of the lime would be approximately a cent per gallon of liquor treated.

Based on an average acid strength for many pickling liquors and an average neutralizing strength for many limes, about a cent a gallon is a good figure to start with in your calculations. If you are treating five thousand gallons a day you have in the neighborhood of $50.00, if I haven't misplaced the decimal point, for the cost of the lime. That gets rather expensive on the basis of 365 days a year. Little thought is given to the differences that exist in limes. Nevertheless small differences become of great importance when you consider the yearly cost of the lime entering the treatment.

I will not attempt to tell you what type of lime to use. You could write to Mr. Hoak at Mellon Institute and receive from him copies of two papers on which we cooperated. These papers attempt to lay the groundwork for a rational approach to the problem of treating sulphuric acid pickling liquor with lime, and I believe the reprints will help you.

You cannot look at the lime solely in terms of its neutralizing power. The difference between using a high calcium quicklime and a dolomitic quicklime in treating a sulphuric acid waste may be as much as one hundred per cent in terms of the solids produced. In the case of the dolomitic material, the magnesium component will render soluble as magnesium sulphate as much as half of the sulphate content of the liquor.

Now if there is a considerable iron content in the waste liquor, relative to the amount of free acid at the time the liquor is discharged, the dolomitic lime may reduce total solids by as much as 37 per cent. In any case, I believe the dolomitic lime will reduce the precipitated solids by at least 30 per cent when applied to the neutralization of sulphuric acid waste pickling liquor.

These solids become appreciable when you enter into the design of equipment or attempt to choose a site for a permanent waste dump for the solids.

When, however, we attempt to choose between a high calcium type of lime or dolomitic type of lime, we must also give some thought to the stream, or water course in which the final effluent is apt to be discharged. Magnesium sulphate imparts permanent hardness to water, and if your effluent were reaching a stream near the intake of a public water supply, magnesium sulphate might be very objectionable. On the other hand, if such stream were not feeding a public water supply. then magnesium sulphate might be of no objection and you could successfully use dolomitic lime, allowing a smaller treating plant, less cost for lime, and in general, a more efficient operation.

You probably realize that a ton of dolomitic lime will neutralize 15 per cent more acid waste than a ton of high calcium lime, and in some cases this might be as much as 30 per cent. The choice of lime becomes very important. There is somewhere in the neighborhood of 200 million gallons of industrial acid waste discharged into Pennsylvania streams each year. This could require as much as 300 tons per day of quicklime for complete neutralization, and result in at least a temporary shortage of lime. So, in choosing the type of lime you must give some thought to the nearness of the source, the size of the source, and it's stability.

Now a lime treating plant, or the essence of it, is simply this: The waste pickling acids are run to a common sump or reservoir, capable of holding possibly two, or maybe three days' production of waste pickling acid. From the reservoir, the acid is admitted to mixing tanks, and to the acid in the mixing tank is added lime, preferably in the form of a water slurry. After a suitable mixing time, the sludge consisting of gypsum, magnesium sulphate and hydrated iron oxides is run into a settling basin or lagoon. After evaporation or other suitable compaction of the solids, these are removed and taken to a permanent dump.

One more thought I would like to leave with you concerns the biochemical oxygen demand test, the BOD test. This test is not as applicable to a ferrous sulphate type of waste as it is to the organic type of waste. Ferrous sulphate and ferrous hydroxide, of course, have an oxygen demand. Very few of you have laboratories that are equipped to perform a BOD test, but I believe most of you have laboratories which could determine the oxygen demands of your waste by the simple use of permanganate. In other words, run an immediate oxygen demand or IOD test, and that should serve at least as a control measure.

Roy F. Weston: There is only one thing I want to mention in reference to American Petroleum Institute separators. While these separators have proven practical in most cases in the oil industry, there are many cases in which they will not produce a satisfactory effluent and some supplementary type of treatment such as flocculation, filtration or some other effluent polishing type of treatment must be provided.

One other thing I might mention pertains to Mr. Siebert's references to the toxicity of various materials to fish. Practically every state law stipulates that it is unlawful to discharge wastes that are inimical to aquatic life. Unfortunately there has been no standard-

ized method for evaluating the toxicity of various substances. Mr. Hart, in cooperation with two ichthyologists, Dr. P. Doudoroff and Dr. J. Greenbank, has developed reproducable evaluation procedures and has published their findings and recommendations in a book entitled, "The Evaluation of the Toxicity of Industrial Wastes, Chemicals, and Other Substances to Fresh Water Fishes." I mention this because the procedures evolved provide a means of estimating permissible concentrations of toxic materials. If industrial people will use the procedures, it will be possible to accumulate a store of knowledge so that industry can predict just how far it must go in the treatment of its wastes to keep them from being inimical to aquatic life.

W. P. Hill: I understand in the near future you will probably have men going around checking and testing to see whether we are going to be permitted to discharge as we have in the past. I was also wondering what method will be used in sampling, how it will be done, especially in tide water. In addition, will you consider what the pH should be, or in other words, will you say it has to have a pH of 6 or above. Also will you check the BOD, the phenol and turbidity?

F. C. Schoen: I can see where we have quite a problem ahead of us. We have small amounts of various type wastes going to the sewers in a number of locations. Our plant is in the center of the city and we have sanitary and storm water sewers running throughout, according to city plans. In times of heavy rains we may be subject to flooding of storm sewers.

After listening to Mr. Siebert and to the various comments, it seems any method of neutralizing would not be very economical or practical unless all operations were concentrated in one spot. This would mean a revamping of the entire plant, again a costly process, and one which will be quite a problem to all of us. I would like to ask this one question: "What will we be required to do to conform to laws and regulations when small amounts of various types of waste are drained to sewers in locations scattered throughout our plants?"

C. S. Cassels: When the analysis of the plant's discharge is made, is there any consideration given to the volume of the stream in which you are discharging? Will your restrictions, or will the restrictions upon the plant depend to any extent on the size of the stream that is receiving your waste? In other words, we are on the Delaware where there is a lot of water; somebody else may be on a creek where there is not much water.

C. L. Siebert: With respect to Mr. Hill's question on inspection and testing as concerns pH, turbidity, and so forth, please bear in mind I am not with the State; and I am not making the state inspections any more, although I used to do that. I am now helping some of you meet the requirements. The method of determining the objectionable characteristics or objectionable effects of the waste waters includes not only examination of the concentrated waste waters themselves but the effect on the stream. What is the water in the stream? How much is it degraded by these waste waters?

Now, let us get a general idea of the attitude of Pennsylvania authorities. I am familiar with this. I am not so familiar with the details of other states. In Pennsylvania there are three kinds of streams as classified by the Sanitary Water Board: first, those clean or relatively clean streams which require a high degree of treatment of all sewage and industrial waste discharging thereto; second, those large streams which afford a liberal dilution factor and require only primary treatment of wastes and; third, those streams so hopelessly loaded with acid mine drainage that little or no treatment may be required.

High degree treatment of sewage is generally considered as reduction of the pollution load, as measured by biochemical oxygen demand, by at least 85 per cent. That is, a sewage of originally 200 parts BOD per million must be reduced to not in excess of 30 parts per million BOD.

Also the policy now applied to industrial wastes, and I say now, because a year or two ago this did not apply, is to ensure that industrial wastes discharged into clean streams must also have the objectionable characteristics of their waste waters reduced by at least 85 per cent, which is equivalent to the reduction effected in sewage treatment. However, industrial wastes are not always measurable by the BOD determination. I am sorry that I lent the thought or appeared to indicate that BOD measurement of copperas was applicable. It is IOD or immediate oxygen demand, not BOD.

But the State, with respect to pickle liquor, requires more than 85 per cent reduction in acid. The free acid must be neutralized and all hydrolizable acid must be eliminated. That is on a clean stream, and I think will be applicable to the second class of stream, also, which is a fair stream.

There is a different formula for the discharge to each of these zones established for the Delaware River by the Interstate Council on the Delaware River. Here in Philadelphia, or just below Philadelphia, you are not required to treat to as high a degree as you would if you were on the upper Delaware, but on most streams of the State, except the main Susquehanna, the Ohio, the Monongahela and the Allegheny, a high degree will apply.

The acid mine drainage streams are in the fourth class and they, so far, have been classified as requiring only the lowest degree of treatment for sewage, which would be comparable to that which is permitted in large streams as the Susquehanna, where the factor of dilution is also considered. The towns on the Susquehanna River all the way up to and including Lock Haven on the West Branch, and all the way up to Wilkes-Barre, on the North Branch, will be required to treat only to the extent of removal of settleable solids which accomplishes about a 35 per cent removal in BOD. For industrial wastes, a higher degree of treatment has been generally required for discharge into those streams. This may seem inequitable in some instances because in the treatment of many waste waters, the removal of the first 30 or 40 per cent is not so expensive, but when required to go up to 85, 90 or more per cent, the cost may increase disproportionately. However, some wastes are so high in pollution load that very high degree treatment is necessary.

An example is the distillery waste from a commercial alcohol plant here in Philadelphia which, before the installation of waste treatment facilities now largely in effect, caused pollution equivalent to the sewage of a population of 3 million, or more than all the city of Philadelphia. This company has been required to treat

to a degree which is approximately 97 per cent, and requires complete evaporation of the thin slop or still wastes after fermentation. Now that is pretty high but, strangely enough, the company is going to net a profit approaching a thousand dollars a day on what is recovered. That is one industry which is going to make money on waste treatment. As a matter of fact, some distillery officials predict that the production of whiskey may become a by-product of the food industry.

Mr. Hill asks about pH and turbidity. These determinations are factors which the engineers of the state include in their findings. A little turbidity caused by inert material is not always harmful. A little color is not always harmful. Some textile mills and dye houses discharge some colors which are innocuous, although they look bad. Remember that the majority of complaints about pollution are caused by what people see or smell. I have seen fish thriving in highly colored water; again I have seen them die in crystal clear water.

However, pH is important. The State of New Jersey has a general condition in its permits which states that no waste water may be discharged which has a pH of 4.5 or less or exceeding 8.4. I worked with a cannery in New Jersey where we treated with lime for precipitation, and we exceeded the 8.4 pH but nobody said anything about it. It is impossible to precipitate colloidal matter with lime without getting a pH in excess of 8.4. But common sense will generally prevail in the interpretation by the State engineers.

Mr. Schoen spoke of their wastes going into the sewers in dribbles. That is a common difficulty. How much pressure will be brought to bear on industries in the city of Philadelphia, is a question, and many of those things will be left to the city. The city is accepting many waste waters into the public sewer system. Where there are new and improved sewage works, the authorities will have to be more particular about what they accept. Many will probably receive notices to discontinue discharges. However, a number of smaller or minimum discharges must be tolerated in the city sewer system where there is a mixture such as is present in Philadelphia. There are, for example, paper and tannery industries discharging into the sewer system. They have no place to install elaborate and stretched out sewage treatment systems. They would have to go up in the air to install complete treatment works. I think the cities are going to be reasonable. They may require partial treatment or regulated discharge so that the sludge doesn't get to the sewers and so that the most objectionable features may be ammeliorated.

Pennsylvania, incidentally, does not want to come into the city sewage system problem and in a city like Philadelphia it does not have to. However, it has much to do in smaller places. The engineers of the state concern themselves only with large industrial waste discharges in cities and only when it appears that the city can't handle the problem or doesn't care to. The State is then permitted to step into the picture, but does so reluctantly.

Mr. Cassels asked whether when analysis of the discharge is made, if consideration is given to dilution in the stream. There are some authorities who insist that whether it is a quart or a million gallons, if fish can't live in it, it is unlawful. The law can be so interpreted but even a fish warden is sometimes fairly human and he isn't going to take a bucket of the strong waste water and see if fish will live in it.

Dilution in reasonable degree is an ammeliorating factor. Nobody can expect to return the streams of this State to their pristine purity. Wherever there are concentrations of people supported by industry, there are waste water discharges — sewage and industrial — and it must be realized that the streams will be degraded to a certain extent.

Pennsylvania hopes that the wastes in the sewage can be so treated that the streams will be, as they say, "of a quality consistent with common decency." There are times when those two words "common decency" have been over-stressed but they are useful in establishing controls where the commonly accepted scientific criteria are inadequate.

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OCTOBER 1, 2, 3, and 4, 1946

MIXED FUELS *in* *Open Hearth Furnaces*

. . . . marked reduction in plant fuel costs resulted from combination firing of open hearths with mixed coke oven and blast furnace gases and fuel oil . . . .

▲ THE fuel bill of any steel plant is one of the largest items of expense and is, perhaps, one of the most susceptible to control. With labor and material prices well standardized, the balancing of the various surplus by-product and purchased fuels offers a fertile field for worthwhile economies.

It is, of course, of primary importance that no by-product fuels be wasted, but the plant fuel study cannot end at that point. If coke oven gas can be sold at a price higher than the cost of the oil to replace it, and the other conditions such as weekend use and distribution lines are favorable, it should be sold and replaced with the cheaper purchased fuel. If all surplus blast furnace gas is used in boilers, replacing a cheap fuel, and high cost purchased fuels such as fuel oil are used elsewhere, the fullest economy is not being obtained.

by J. C. Foster

COMBUSTION ENGINEER

BETHLEHEM STEEL COMPANY

BETHLEHEM, PENNSYLVANIA

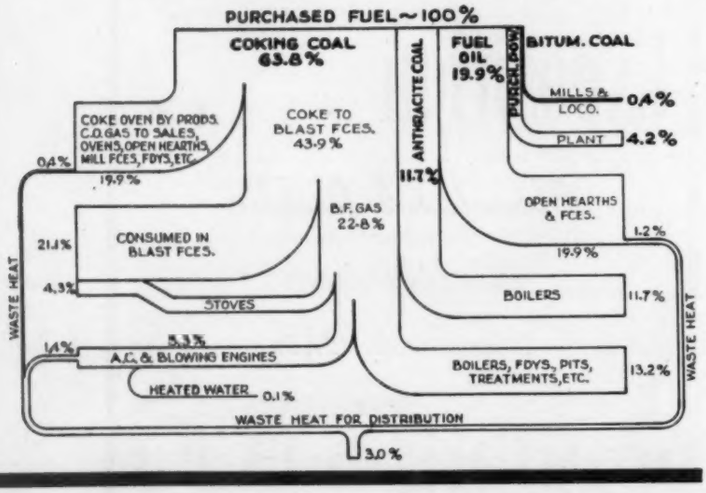
The Bethlehem plant of Bethlehem Steel Company is located in a high cost area for bituminous coal, power and fuel oil. Its cheapest fuel is the nearby anthracite coal which is mostly suitable for steam use and not particularly cheap by usual comparisons. The plant fuel balance in this case is worked out for the purpose of replacing all possible fuel oil and power with surplus by-product fuels, utilizing the recovery of waste heat from furnaces and gas engines for steam generation, and using only the surplus blast furnace gas for steam generation.

Figure 1 shows a simplified chart which outlines graphically the fuel balance of the plant. As indicated in the chart, the open hearth department is the largest fuel consumer in a steel plant, with the exception of the coke works and blast furnaces, and as such, it is the most logical place to look for an increase in the use of surplus coke oven and blast furnace gas. It has further advantages in that it consists of large units and operates through weekends when the problem of disposal of surplus gas is at its worst.

Seventeen years ago a mixture of coke oven and blast furnace gas of 180 Btu was introduced into the producer gas fuel mains to supply about 25 per cent of the total open hearth furnace fuel, and was used regularly as long as producer gas was used, and the surplus mixed gas was available. This was one of the first of many changes made about this time in the open hearths and was, perhaps, responsible for starting a program of fuel economies which resulted, over a period of three years in a decrease of about 30 per cent in the fuel rate.

After some development changes, one open hearth furnace and later two were operated in regular practice

Figure 1 — The fuel distribution flow chart for the Bethlehem plant of the Bethlehem Steel Company shows a high efficiency in the utilization of fuel.



Presented before AISE, Philadelphia District Section Meeting, February 2, 1946.

on mixed gas and fuel oil, when surplus gas was available during the seven year period from 1930 to 1937. At the same time the remainder of the furnaces were equipped to burn surplus coke oven gas alone with oil, and the open hearth furnaces were used to eliminate bleeding of our weekend surplus coke oven gas.

This experience, together with the construction of an additional blast furnace in 1942, prompted the installation of mixed gas firing on ten open hearth furnaces along the same lines as the original one built in 1930. One of these furnaces has now been in operation over a period of 14 months and has furnished the background of experience upon which the effects on the plant fuel balance are based as shown in Table I. This table illustrates the effects from a plant standpoint of varying fuel combinations in open hearth furnaces. The replacement of fuel oil with gaseous fuels which are made available by using anthracite coal in the boilers and by the reduction of bleeding losses show the possibilities of appreciable overall savings in purchased fuel costs. In these cases the use of a purchased fuel, anthracite coal, for boiler firing makes improved plant fuel costs possible by permitting the plant by-product gas fuels to reduce open hearth fuel oil requirements. The net fuel cost figures in the table are based on the purchased fuels of oil and anthracite coal at current market prices.

Perhaps a more concise picture of the flexibility of these units may be gained from the fuel schedules and

TABLE I

Plant Distribution of Fuels with Fuel Variations in Open Hearth Furnaces

(Per 24 Hours)

Open hearth fuel schedules 10 furnaces	Fuel distribution						Cost
	Open hearth			Boilers		Bled	Net fuel cost to plant dollars
	Oil	C.O. gas	B.F. gas	B.F. gas	Anth. coal	C.O. gas	
	Gals	M cu ft	M cu ft	M cu ft	Net tons	M cu ft	
100 per cent fuel oil	63,000	.....	.....	20,000	.....	14,000	2900.
Min. C.O. gas	40,000	4,000	20,000	.....	85	10,000	2200.
Med. C.O. gas	20,700	10,000	20,000	.....	85	4,000	1300.
Max. C.O. gas	11,000	14,000	20,000	.....	85	.....	900.

TABLE II

Firing Schedule for Open Hearth Furnace

Operation	C.O. gas	B.F. gas	Oil
	M cu ft	M cu ft	Gals
Melt. down	80	100	....
After hot metal	40-60	100	100-150
Finish. heat	40	100	125

TABLE III

Operating Performance Data, Open Hearth Furnaces

1945	No. 36 furnace			O.H. No. 2 — Shop average (16 furnaces)		
	Prod.	Fuel rate	Fuel cost	Prod.	Fuel rate	Fuel cost
	Net tons per hour	Pounds coal equivalent per net ton	Dollars per net ton	Net tons per hour	Pounds coal equivalent per net ton	Dollars per net ton
March	9.85	370.5	1.3210	10.21	302.2	1.225
April	10.29	340.6	1.2113	10.16	295.2	1.214
May	10.40	313.9	1.1492	10.30	292.8	1.189
June	9.57	360.2	1.2570	9.36	308.6	1.257
July	10.07	348.1	1.2230	9.66	304.1	1.226
August	10.20	341.3	1.1958	9.92	297.9	1.213
*Campaign	10.045	340.0	1.2074	9.92	300.0	1.2193

*The campaign figures exclude March since that month includes both a warm-up and experimental work.

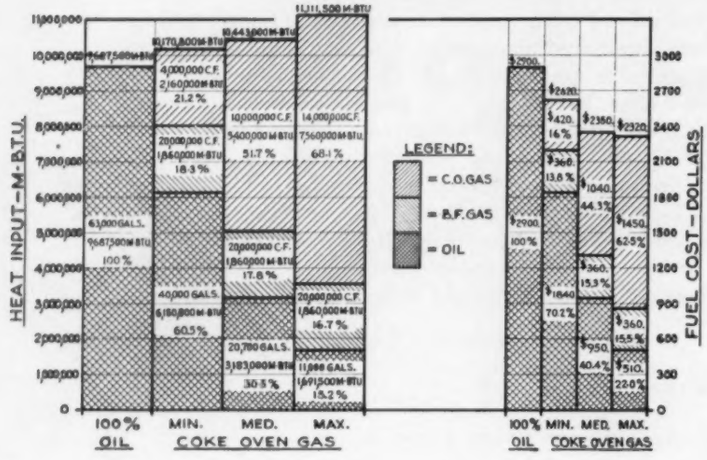


Figure 2 — Graphic calculations of fuel schedules and costs show the most economical combination of fuels for the operation of 10 mixed gas open hearth furnaces.

cost data sheet of Figure 2. In the first column showing fuels is indicated the block of fuel required to operate these ten furnaces for 24 hours on oil, with the cost of that fuel represented by the fifth column. As fuel oil is replaced with gaseous fuels, the total Btu required to operate the furnace tends to increase. However, since these gaseous fuels would otherwise be bled, representing a total loss, or would replace the cheaper anthracite coal used in boilers, a more favorable picture is presented. On this basis their values have been represented in Figure 2 as the dollar value of anthracite coal at $4.20 per net ton. The most interesting item to note is that in spite of the fact that the total fuel input when using gaseous fuels has increased 15 per cent above normal requirement when oil is used, the fuel cost to the plant has decreased 20 per cent.

In order to maintain this flexibility of fuels, all first helpers have been instructed to follow the fuel schedule shown in Table II. This represents a maximum gas burning schedule with oil held to a minimum. Should the plant fuel balance so dictate, oil and coke oven gas may be varied as required. In view of the extreme flexibility demanded of these furnaces, it was deemed necessary to give the first helpers a complete control panel, which required an expenditure of approximately $15,000 per furnace or $150,000 in the case of ten furnaces for the necessary controls and mixed gas equipment as shown in Figure 3.

In Figure 4 is shown how the two gases, coke oven and blast furnace, are mixed volumetrically into the desired proportions by means of the two volume regulators. The mixture then passes through the positive displacement blowers which boosts the pressure from 4 to 5 in. water column to a range of 1 to 5 in. mercury column.

This final gas pressure is entirely dependent upon the volume of gas being simultaneously consumed in the furnaces and is automatically controlled by the pressure regulator. The gas is then carried through pipes, without preheat, to the ends of the furnace where gas reversing valves are tied into the regular furnace reversal. Figure 5, a more detailed sketch of the control layout, illustrates the overall furnace control system.

In the study for development of a burner for use with mixed gas, it was anticipated that it would be feasible to use an enlarged conventional type coke oven gas burner. This type burner gave a very late burning characteristic, with the heat tending to freeze on the incoming or burning end while the outgoing slope and end walls were being burned down. This condition was corrected by shortening and raising the gas burner as shown in Figure 6. It is believed that the increased turbulence of gas and air mixing, brought about with this relocated burner, is the main factor in the better burning characteristics obtained.

Preheating of mixed gas results in the cracking of some of the gas components into free carbon that tends to develop a very heavy luminous flame. Perhaps one of the most outstanding characteristics in the operation of a mixed gas furnace is the nature of the flame when the gas is not preheated. During melt-down, the flame

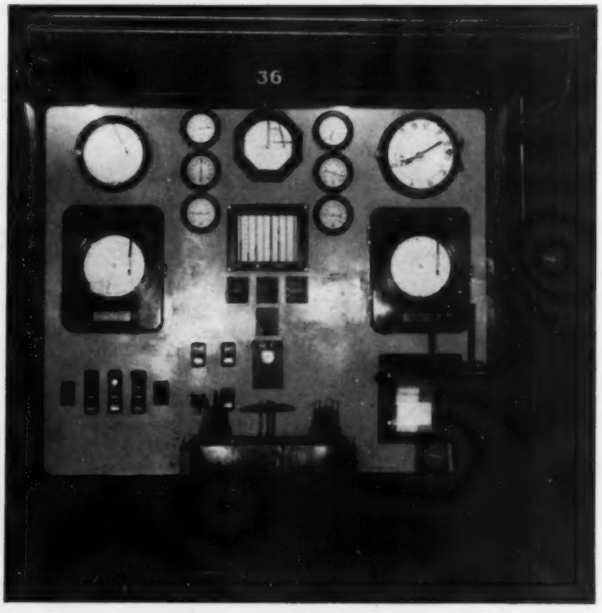


Figure 3 — Control panel used when open hearth furnaces are fired on gas-oil mixtures.

is not visible in the furnace, and the only way one can see that fuel is being burned in the furnace is by the indication of the meters, and the fact that the scrap is melting.

The advantages of mixed gas as a fuel are usually lost as soon as hot metal is added. If luminosity is not developed in the flame by the use of oil in addition to a high furnace pressure, the slag may start to foam. This phenomenon is so marked that on numerous occasions

mixed gas heats foam up and out the furnace door every time oil is taken off, only to settle down and stop foaming when the oil is turned on again.

During a six month period, or a normal campaign, a furnace was operated with mixed gas as the principal fuel. The campaign consisted of 293 heats, and 79.36 per cent of them were mixed gas heats. In most cases, the gas was ordered off the furnace because of plant gas shortages, otherwise, the percentage of mixed gas heats would have been higher. The data shown in Table III gives performance comparisons between the mixed gas furnace and open hearth shop average of sixteen furnaces on fuel oil. Attention is called to the net ton per hour column. With the exception of the month of March, the furnace out-performed the shop, both from a production standpoint, as well as in fuel cost. It should be noted that the fuel costs in the table are based only on the plant fuel charges to the open hearth of both the by-product and purchased fuels consumed. This cost figure is more favorable if one considers that 66 per cent or ⅔ of the total fuel consumed in this furnace are by-product fuels and might otherwise have been bled.

An important factor to be considered in the operation of an open hearth furnace is the effect of fuel or types of fuels on refractory life. Fourteen months experience tends to indicate that roof, end, and front wall life is equal to that normally experienced in the shop. A more favorable condition was found in the checker chambers

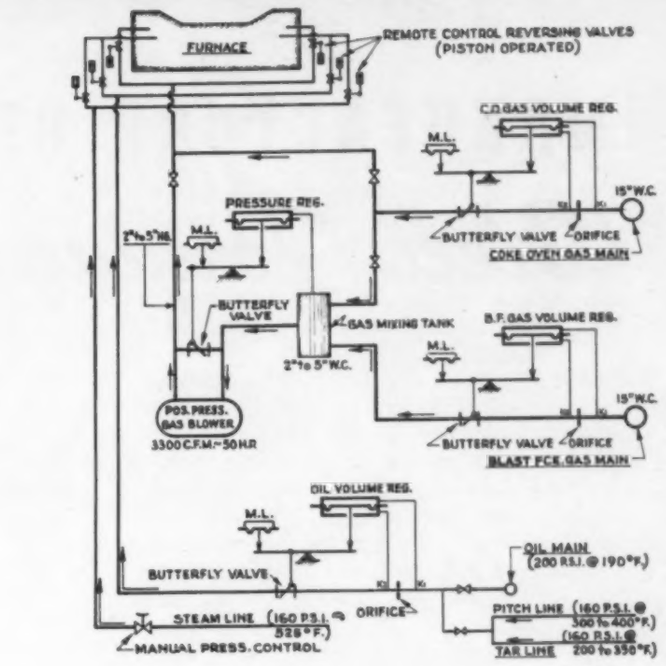


Figure 5 — Typical arrangement of multiple fuel controls for open hearth furnaces.

▲

Figure 6 — It was necessary to modify the gas burner slightly to use it most effectively for burning mixed gas.

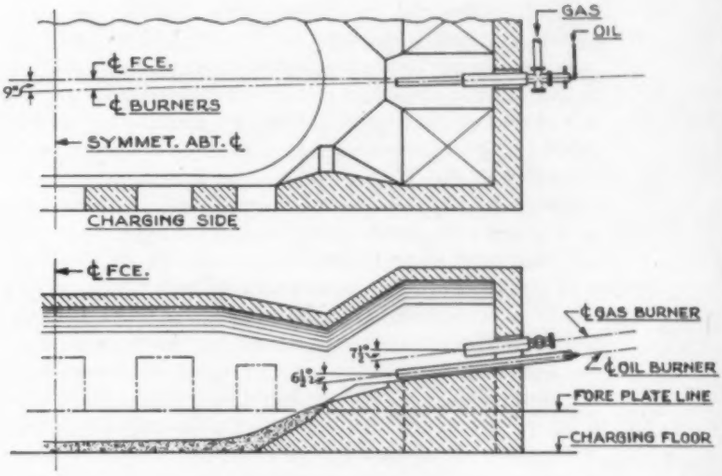
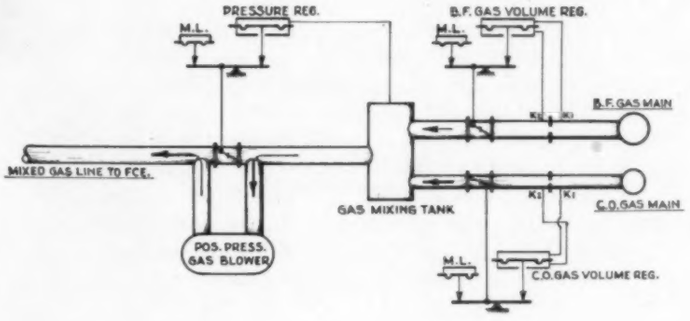


Figure 4 — The open hearth furnace mixed gas controls are arranged to give any mixture of coke oven and blast furnace gas which is desired.



which remained cleaner, and the dirt that had accumulated was easier to remove.

In the operation of our furnaces with mixed gas no particular advantage to the open hearth operator as such has been developed. However, the flexibility in the substitution of the two by-product fuels for the normal fuel oil has made it possible to readily meet variable plant heating requirements as they occur. The effect on the general plant fuel balance is favorable in prevention of gas bleeding losses, while the flexibility of fuel use possible, places the plant in an improved position to meet the fluctuations of quantity and price of purchased fuels.

In conclusion it may be said that these combinations of conditions add up to worthwhile improvements in general plant fuel operating practice, as well as providing the means of effecting very substantial savings in total fuels.

MANUFACTURE OF 155 MM *Steel Forgings*

. . . . the quick adaptation of steel plant shops in the United States to ordnance production in World War II was a major factor in the Allied victory . . . .

by W. F. Jones, MANUFACTURING DIVISION
TENNESSEE COAL, IRON AND RAILROAD CO.
ENSLEY, ALABAMA

▲ ENGINEERING studies leading to the design of a process for producing 155 mm shell forgings were begun at Ensley in the latter part of 1940. These studies included trips to the arsenal at Frankford, Pennsylvania, and to some manufacturing plants then engaged in producing shell forgings. During the early stage of that period no 155 mm forgings were being produced. The Frankford Arsenal was producing a few 75 mm on an upsetter. A small quantity of 75 mm and 90 mm forgings were being produced at other plants. Several of the heavy machine builders were considering various methods of manufacturing shell forgings, some of which were offered to prospective shell makers. One of the processes offered was the Witter process. In this process heated forging blanks are pierced in a press then rolled to size in a three roll cluster mill. This is an adaptation of a mill for producing tubes. The process was developed and was in operation in several shell plants.

The process adopted by the Tennessee Coal, Iron and Railroad Company is known as the pierce and draw method. In this method, heated forging blanks, or slugs, are pierced in a die and are then drawn to size and length in draw presses. All draw presses in the early stage were equipped with a series of draw rings. The number of rings for 155 mm forgings ranged from 7 to 9, with each successive ring being smaller in diameter than the one preceding it. With the use of draw rings a large number of the uncertainties in shell manufacture are eliminated.

The use of rollers in place of draw rings for producing 155 mm forgings had not been developed in this country at that time. Some forgings of different sizes had been produced with roller type draw benches, but in small quantities. Some of the prominent forging press manufacturers doubted that rollers could be used for producing 155 mm forgings.

The use of draw rings offered assurance of acceptable forgings, but due to their short life, their high cost and the limited production of forgings, the use of rollers was preferred.

After considerable experimentation roller type draw benches proved quite satisfactory both from the standpoint of economy as well as quality. More than 50,000 forgings have been produced from one set of rollers. Such production cannot be approached with draw rings.

Orders were placed in December 1940 for the forging equipment, which included one 320 to 400 ton turret type piercing press; two 100 to 140 ton roller type draw benches; two 475 gpm, 2500 psi, horizontal duplex pumps, and all necessary controls. In January 1941 orders were placed for two rotary hearth furnaces having a rated capacity of 100 forgings each per hour. Most of the auxiliary equipment was built in the T.C.I. shops from designs developed by the T.C.I. engineering department. A more detailed description of all of the equipment will be given later.

The first unit for producing 155 mm shell forgings was placed in operation in December 1941. It was located in an existing building where a few alterations were necessary. The original building covered about 42,000 square feet. To this was added about 7000 square feet, in more or less temporary structures. A billet storage yard was provided adjacent to the shop. This billet yard is served by a ten ton 50 foot span crane equipped with magnets for handling billets from cars to storage area and from storage to the notching and breaking equipment.

The second unit, a duplicate of unit number one, was installed during 1944 and was placed in operation

Presented before AISE, Birmingham District Section Meeting, October 29, 1945.

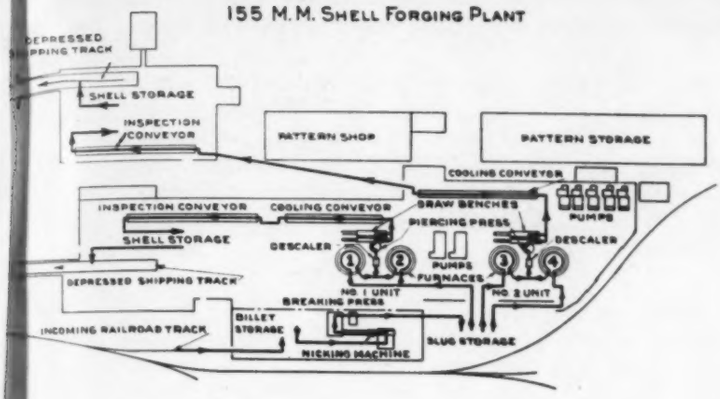
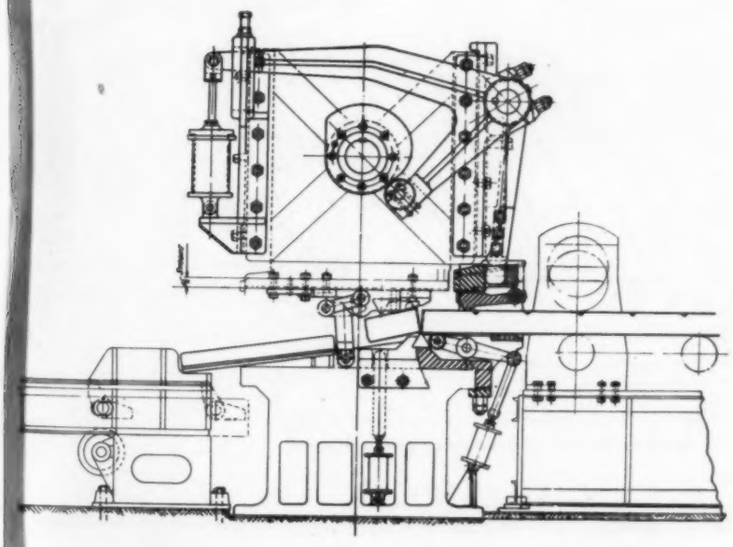


Figure 1 — Plant layout and flow of materials for the 155 mm shell forging plant were compactly arranged.

▲

Figure 2 — A 1200 ton crank press was fitted so as to break notched billets into slugs.



in October 1944. The process of manufacture is exactly the same as for number one unit, and the equipment is similar. Some substitutions were necessary in the second unit because of wartime restrictions and available auxiliary equipment. For this addition, another existing building covering about 12,100 square feet was used and building extensions totaling about 21,000 square feet were added. The plant layout and diagram of the flow of materials is shown in Figure 1.

Size and shape of billets — One of the first problems to solve, after the process of manufacture was determined, was the size and shape of billets to be used. Billets, 6 in. square with $\frac{5}{8}$ in. round corners, weighing about 10 lb per linear inch, were selected, because billets of this size and shape could be produced at Ensley without any changes to the mill or mill equipment. The Ensley mill was selected to roll the steel for the shell shop.

NICKING AND BREAKING

After experimenting with several methods of separating billets into slugs, it was decided to nick the billets with oxy-acetylene torches on two opposite sides and then to break them at the nicks. At first, it was considered necessary to nick the billets on two opposite sides to insure square breaks. Later, satisfactory breaks were obtained by nicking on one side only.

Nicking machine — An automatic multiple torch nicking machine was developed especially for nicking billets. It was arranged with six or more torches cutting simultaneously. The notches cut by the torches were about $\frac{1}{4}$ in. wide and about $\frac{5}{8}$ in. deep and were cut vertically on one side of the billets. The torches were attached to a frame which was raised and lowered by a variable speed electric motor through a rather unique drive. In operation, the torches were lowered to the bottom of the billets and held in this position until the starting points of all notches were preheated, then raised slowly and cutting as they traveled upward. The spacing of the torches was adjustable, thus the lengths of the slugs could be varied, to compensate for slight variations in the billet section and provide for uniformity in the weights of the slugs to be forged. Billets were fed to the nicking machine on driven rollers. After nicking, the billets were carried crosswise on a transfer conveyor to a position suitable for feeding to the breaking press. Water was sprayed on to the nicks cut into the billets as quickly as possible after nicking. The quenching action of the cold water provides cleaner breaks and lightens the load on the breaking press. One nicking machine and one breaking press furnished sufficient slugs for two forging units.

Breaking press — Suitable dies and fixtures were fitted to a 1200 ton crank press driven by a 40 hp motor at the rate of 20 strokes per minute. Length of stroke was $2\frac{1}{2}$ in. While this press was of larger capacity than required, it was on hand and available. Due to its massive size very little trouble was experienced from breakdowns.

The arrangement of dies and fixtures for this press is illustrated in Figure 2. Nicked billets were turned after quenching and were delivered with the nicks on the top to the breaking press on driven rollers. A pair of pinch rolls fed these billets against a stop which positioned the first nick directly over a knife edged anvil fixture. This fixture was located on the platen of the press. A knife edged anvil was attached to the ram of the press at a point about 10 in. ahead of the nick. There was an air cylinder operated hold-down fixture located behind the first nick. The hold down was released by the action of a cam attached to the front end of the main shaft of the press. To obtain square breaks it was necessary to have the nick in the billet located directly above the lower or stationary anvil. It was also necessary to have the anvil which is attached to the ram, as well as the hold-down spaced at equal distances

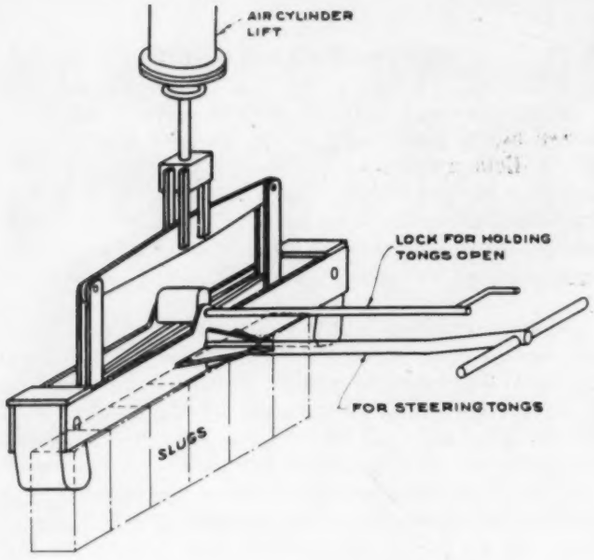


Figure 3 — A special tong was used which lifted six slugs at a time into the tray shown in Figure 4.

from the point to be broken. When this relation was maintained, few breaks occurred which were not suitable for forging.

Broken slug handling — Broken slugs were carried endwise from the breaking press along a conveyor with a reciprocating motion. This allowed time for any defective slugs to be removed by hand during the return stroke of the conveyor. The slugs fell from the end of this conveyor and were upended in a trough located at right angles to the conveyor, where they were gathered into groups of six slugs on end standing in a row. A pair of tongs, Figure 3, hanging from an air hoist attached to a trolley, was used to place the slugs into pans or trays. These tongs handled six slugs at each lift. The pans or trays were designed to carry 24 slugs in four rows, six slugs to each row, and were arranged to be handled by lift trucks. Figure 4 illustrates the construction of the pans, and shows how broken slugs stood on end in the pans. Lift trucks carried the loaded pans to storage areas where visual inspection found inclusions or other defects in the metal. Lift trucks were also used to transport slugs from the storage areas to a spot in front of each furnace ready for charging.

The use of fork trucks for handling the broken slugs proved to be quite satisfactory and the practice of maintaining a stock of broken slugs in storage contributed to a continuous operation of the forging plant. This feature took up any slack due to irregular deliveries of billets from the mill and delays in the nicking and breaking operations.

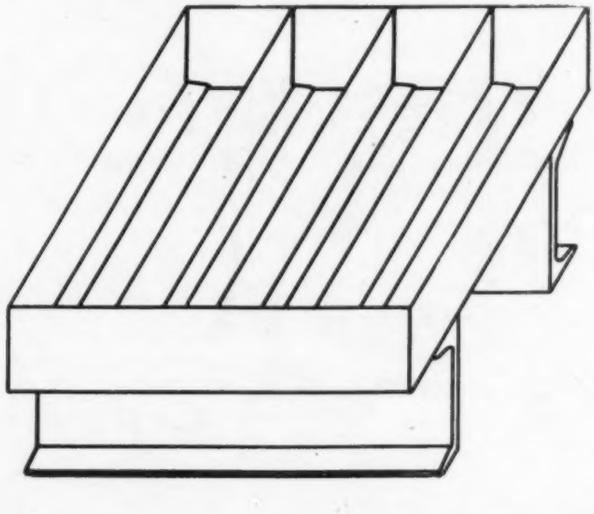
FURNACE CHARGING AND DISCHARGING TONGS

Compressed air-operated tongs were provided for charging and discharging the furnace; these tongs hung from trolleys running on overhead tracks arranged radially with two to each furnace, one to serve the charging door and one to serve the discharging door.

The tongs were equipped with air cylinders for operating the tong gripping jaws and for raising and lowering the tongs. Control valves were located on the handle of the tongs. The trolleys, from which the tongs hung, were equipped with ball bearing wheels, which enabled the operators to easily move the tongs into and out of the furnaces by hand.

Valves for controlling the furnace door lifting cylinders were also located on the handle of the tongs. With this feature, the opening and closing of the furnace doors was accomplished by the tong operators so that the doors remained open only a minimum of time. These tongs are illustrated in Figure 5.

Figure 4 — The trays in which slugs were placed were designed to be handled by lift trucks.



HEATING

The rotary hearth furnaces employed for heating the slugs are known as the doughnut type. The hearth of each has a mean diameter of 22 ft and is 4 ft 6 in. wide, with an area of 320 square feet. The firing chamber through which the hearth travels is 5 ft 4 in. wide and 5 ft 1½ in. high. The fuel used was natural gas at 980 Btu gross, 882 Btu net, per cu ft. The temperatures and pressures were automatically controlled.

Each furnace was equipped with a 6000 cfm fan direct connected to a 20-hp, 1760 rpm, motor. Furnace pressure was controlled by motor operated stack dampers with pressure tubes located in the combustion chamber of the furnaces.

Each furnace of No. 2 unit was equipped with 23 burners, of which nine were located in the inside wall,

and the others in the outside wall. All of the burners except one were grouped so as to provide three separate zones. The temperature of each zone was controlled separately by means of radiation pyrometers which in turn controlled motor operated valves located on the gas and air pipes for each zone. The one burner not automatically controlled was located near the charging door. The air and gas valves for this burner were manually operated.

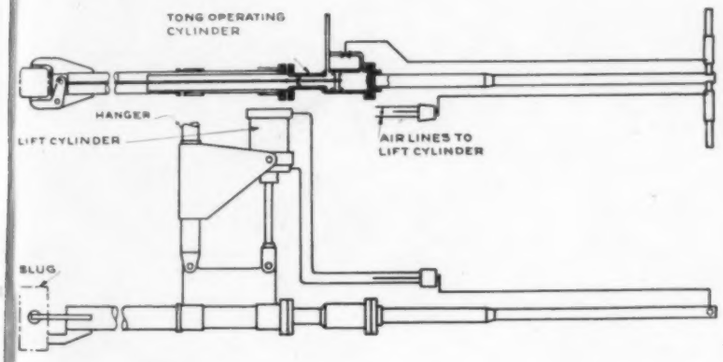
The temperatures for each zone were maintained as follows:

Zone No. 1 — 2000 F to 2100 F.
Zone No. 2 — 2300 F to 2350 F.
Zone No. 3 — 2350 F to 2400 F.

Discharge temperature of slugs was 2250 F.

The maximum firing rate for the above burners was 36,000 cu ft of natural gas per hour. The furnace pressure was plus 0.040 inches of water. The hearth capacity was 280 slugs on end in rows across the hearth with four

Figure 5 — The tongs used to charge and discharge billets from the furnace also have on them the control valve for the furnace doors.



slugs per row, or 350 slugs on end in rows with five slugs per row. The common practice was to operate with four slugs per row as the spacing of slugs was better, and this produced better heating. The practice of charging five slugs to the row was employed when operating one unit with one furnace. The hearth speed varied from one revolution in 1.7 hours to one revolution in 3.3 hours.

As stated above each furnace was rated at 100 sluge per hour but in practice after some changes were mads in the location of burners, the average heating rate for each furnace was 150 slugs per hour or 9.2 tons per hour with 280 slugs on the hearth. The maximum was 195 slugs per hour per furnace when 350 slugs were charged on the hearth. Average heating rate was 12 tons per hour. The operating fuel consumption was 2,500,000 Btu per ton.

The salient features of the furnace controls are shown diagrammatically on Figure 6. This diagram shows the arrangement and number of burners in the furnaces provided for unit No. 2. The arrangement and number of burners in the furnaces for the No. 1 unit was slightly different.

CONVEYING SYSTEM BETWEEN FURNACE AND PIERCING PRESS

Heated slugs were carried from the furnaces to the piercing press by a system of chain conveyors. These conveyors were automatically controlled, except that the speed of the conveyor feeding the piercing press was manually controlled by the piercing press operator. Thus slugs could be delivered to the piercing press at a rate to suit the varying conditions in the forging operation.

FORGING OPERATION — DESCALING

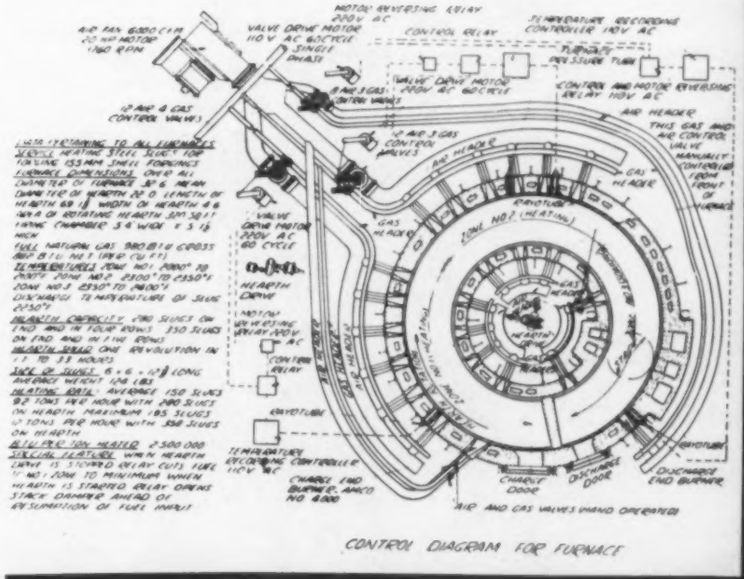
The descaler consisted of a steel shell about 2 feet in diameter and about 6 feet long. Around its circumference were located nine spray nozzles with orifices $\frac{1}{32} \times \frac{1}{2}$ in. These nozzles were arranged to spray the slugs on all four sides and at both ends.

The chain conveyor feeding the piercing press carried the slugs through the descaler where the slug contacted a flag connected to an electric contactor which opened a pilot operated hydraulic valve, allowing water from the 2500 psi hydraulic system to spray the slug. The speed of the chain was such that the sprays were turned on only a fraction of a second for each slug. The arrangement of the descaler is shown in Figure 7.

FORGING OPERATION

The process used at this installation is graphically illustrated in Figure 8. The drawing shows, first, the cold slug used for forging. This slug was 6 in. square

Figure 6 — Burner arrangement and control system for heating the slugs provided flexibility as the demand varied.



with 5/8 in. round corners and was broken to a length of about 12 5/8 in., weighing about 124 pounds. Next is shown the bottle formed by one stroke in the piercing press. Third, the drawing shows the various passes in the draw bench. Fourth is shown the finished forging weighing about 121 pounds. The bottom of Figure 8 shows enlarged sections of the forgings at the various passes, and finally the complete detail of the finished forging.

Piercing — Piercing was done on a 320 to 400 ton vertical turret type hydraulic press operating under 2500 psi of water. The main cylinder and the base of the press were tied together by three massive forged square columns. The portion of the columns immediately beneath the cylinder serve as guides for the cross head. One of the columns immediately above the base was turned to a diameter, and serves as a pivot around which the turret rotates.

The outstanding feature of this press was the turret, because of the fact that four punches are employed, which are located on a circle coinciding with the center of the die pot and 90 degrees apart. The turret, including the punches, was arranged to rotate 90 degrees at each stroke of the press so that each one of the four punches consecutively was positioned under the die pot. Due to this arrangement, simultaneously a hot slug could be deposited on one station above an idle punch, one slug could be pierced forming the bottle, and at the third position, a pierced bottle could be removed. The fourth position on the turret was idle and was used as a punch changing station, and for lubricating the punches.

The bearing which centered the turret around its pivot was adjustable in four directions. The turret table was equipped with four adjustable notches arranged to receive an hydraulic operated finger, which served to fix the four punches radially under the die pot. Thus it was possible to align the press to maintain concentricity in the forgings.

A high rate of production could be obtained with the turret arrangement due to the rate at which hot slugs could be fed to the press. As many as 390 slugs have been pierced during one hour periods. However, the average was considerably less.

The life of the piercing punches was also improved on this type of press because only one out of four punches was used at a time. The die pot liner on the other hand is subject to more severe service, as there was only one in use. Proper lubrication and cooling of die pot liners and punches was of utmost importance. Arrangement of punches and dies for the piercing press are shown in Figure 9.

Drawing — The drawing of pierced slugs (bottles) from the piercing press was done on two 100 to 140 ton hydraulic roller type draw benches. The cylinders on these benches were of the double acting inside packed type. When the pull back ends of the cylinders were exhausted, the force exerted was 140 tons. When the pull back was not exhausted the force was 100 tons. The benches were operated in this case at 100 tons pressure so that only a three-way operating valve was necessary to control the bench. This valve was air pilot operated, the air cylinder being controlled by solenoid operated air valves arranged for both manual and automatic control. In this manner, the plungers were reversed without shock. A choke was provided on the back end of the plunger which fitted a cavity in the cylinder head at the point where the supply and exhaust connection was made, providing a cushion to soften the impact on the return stroke. These features provided a very smooth, quiet acting ram.

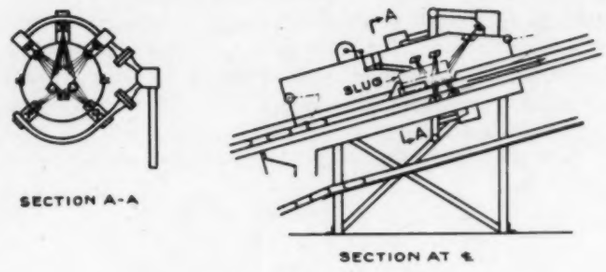


Figure 7 — The descaling water valve was opened when the slug tripped an electric contactor.

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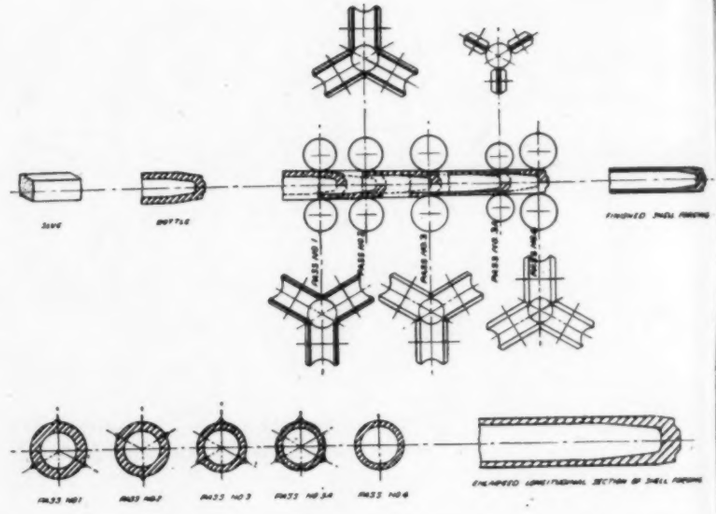
Figure 8 — Five passes were required to roll the bottle into the finished shell forging.



In drawing the bottles formed in the piercing press to finished size and shape, the use of mandrels was required. These mandrels were shaped to provide the required contour and size of cavities in the shells. As these cavities were not subsequently machined, only very slight variations in dimensions and surface conditions could be tolerated.

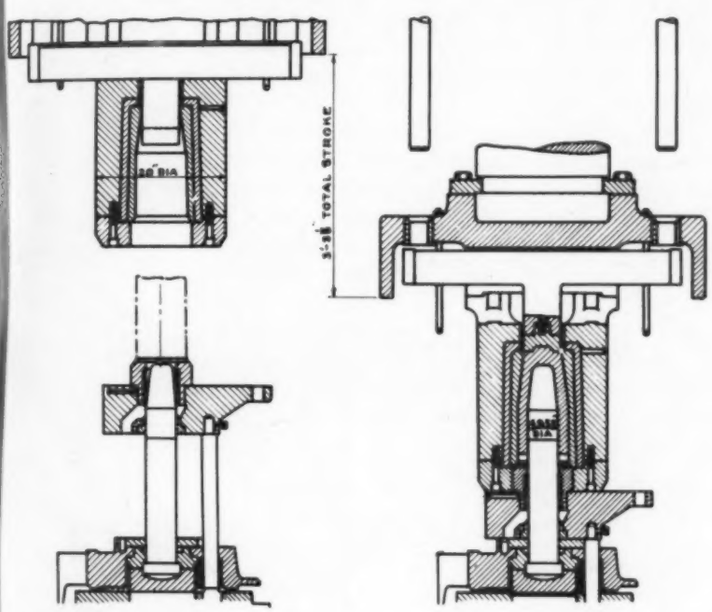
The mandrels were inserted into the partially formed cavities in the bottles previously produced at the piercing press. The mandrels on which the hot bottles were mounted were then forced through a series of passes,

each pass consisting of three rollers, assembled in housings. The proper draft for each pass was accomplished by varying the dimensions of the rollers. Considerable experimenting was necessary to arrive at the proper shape and dimension for each pass.

There was a tendency for the metal to be drawn and flow ahead of the mandrels causing distortion at the bottom of the cavities. To overcome this defect, it was necessary to increase the work done in some of the passes, so that sufficient resistance was produced to maintain the end of the mandrel firmly against the bottom of the cavity.

The critical pass in which to prevent this defect was No. 3. If a draft of 0.630 in. was provided at No. 3 pass, no distortion would occur. This draft was maintained

Figure 9 — The punch press had four punches and while one slug was being punched preparatory operations were taking place on the other punches.



at Ensley for many months, except that during the last six months of operation, it was reduced to 0.540 in. with satisfactory results.

In the operation of draw benches such as described above, roller housings stretch slightly under the stress, making it impossible to maintain rollers in a position which will avoid flashes, or fins on the forgings at the intersections of the rollers. These fins do occur, and the height of them is in proportion to the draft taken at that particular point.

As the fins were unavoidable, it was necessary to control their shape, and this was done by machining the rollers to provide proper contours. If no provisions were made to control the shape of the fins, they usually formed about $\frac{1}{32}$ in. thick and about $\frac{1}{4}$ to $\frac{5}{16}$ in. high. Fins thus formed in No. 1 pass were rolled down flat on the forging in No. 2 pass where more fins were formed in new places only to be rolled down in the succeeding pass, and so on thus causing seams or laps in the surface of the forgings. These were objectionable and could cause rejections.

To overcome this condition, the spaces between the rollers were machined to form fins from $\frac{5}{8}$ to $\frac{3}{4}$ in. wide at the base with tapering sides forming beads triangular in section. This eliminated the seams or laps. Beads of this shape cause deformation of the cavity. Pressure on these beads when passing through the rollers caused small corrugations at points between the beads; these corrugations changed position in the forging as it passed from pass to pass, and if not corrected would be the cause for rejected forgings.

To overcome this condition, the rollers of the last pass were designed to take a very light draft of 0.050 to 0.070 in., and rollers were machined and fit together as closely as possible in an effort to avoid fins in this pass. But with all of the care possible, fins were formed of from 0.025 to 0.035 in. high. These slight fins were objectionable to the machiner, whose carbide tipped lathe tools suffered from the blows given by even these slight fins when machining. To overcome these, an auxiliary pass was provided and located between pass No. 3 and the last pass. This auxiliary pass was equipped with 3 rollers with flat faces $\frac{3}{4}$ in. wide. The rollers in this pass were set to roll grooves in the forging at the locations where fins would be formed at the last pass. These grooves were $\frac{3}{4}$ in. wide and 0.035 in. deep. This is shown in the diagram of Figure 8.

A set-up of this kind produces acceptable forgings, with a reasonable tool cost. One set of rollers will produce approximately 100,000 forgings.

Proper lubrication and cooling of the mandrels are quite important, as both contribute to the accuracy of the forging and to the life of the mandrel tips. Lubricant was sprayed onto the mandrel tips at each stroke of the press. Water was also sprayed on the mandrel tip during the idle period between strokes. The spraying had to be done with care to insure uniform cooling of the mandrel and tips. Mandrels cooled more on one side than the other tended to warp thus making crooked forgings.

Stamping — After passing through the draw benches, all hot forgings were stamped with identifying symbols. These symbols indicated the manufacturer, the heat number, the crew number and also the draw bench on which each forging was drawn.

COOLING CONVEYOR

The cooling conveyor consisted of two strands of 12 in. pitch chain about five feet apart. The two strands of chain were connected at intervals of one foot by flights or cross members. Each cross member was provided with four pegs spaced one foot apart across the conveyor. The pegs were of cast iron and were of sufficient length to support the shell forgings so that their open ends cleared the cross members by about six inches. The ends of the pegs on which the forgings rested were shaped to conform with the shape of the shell

cavity to prevent injury to the forgings when dropped on to the pegs. The conveyor was 120 feet center to center of sprocket shafts. This length accommodated about 496 forgings.

The control was arranged for push button starting. A cam type limit switch controlled the travel so that four pegs were positioned for loading. After loading four pegs, the conveyor was advanced one foot, bringing four more pegs into position for loading, etc. The conveyor was enclosed to allow for controlled cooling. The forgings were cooled slowly down to about 900 to 1000 F, then air was forced through ducts, cooling the forgings more rapidly down to about 400 F to 600 F. To further reduce the temperature for suitable inspection, water cooling sprays were used. One motor driven hot concentricity tester was located near the loading end of the cooling conveyor. This tester was used only occasionally, and especially after changing tools on the piercing press or when the piercing press had been adjusted.

INSPECTION

The cooled forgings from the discharge end of the cooling conveyor were carried by a system of conveyors to a station where a motor driven cold concentricity tester was located. This tester was of the expanding mandrel type, with two dial indicators contacting the rotating forging on the outside. All cold forgings were tested for concentricity. Any forging showing more than the allowable amount of eccentricity was marked with crayon indicating the exact amount of eccentricity. Any of these eccentric forgings, which could not be reclaimed by special care in machining were scrapped.

The inspection table was about 140 feet long and 5½ feet wide. A single chain conveyor ran along the center of this table from end to end. This chain carried the forgings in groups of 100 or more along to positions on the table convenient for inspection. The forgings were removed from the chain to the table by hand. After inspection, they were loaded back on the chain by hand. The chain carried all forgings to a discharge arrangement at the end of the inspection table.

All class "A" forgings were taken directly from the inspection table conveyor and stacked in lots ready for shipment. Forgings requiring hospitalization were handled by lift trucks to shot blast machines, reamers, or saws according to the nature of the defect. After minor defects were corrected forgings were stacked with the other forgings in their proper lots. Forgings were loaded into box cars with lift trucks equipped with seven hinged fingers, so spaced that they would enter the cavities of seven forgings. Seven or more forgings could be handled at one time as the forgings could be pyramided on top of the bottom row. Seven fingers were used as that number of forgings was a multiple of the number that would lay side by side across an ordinary box car, thereby facilitating packing the forgings for shipment.

Ladle analysis — The Army Ordnance specifications for shell steel are as follows:

C	Mn	P	S	Si
0.49/0.56	0.80/0.95	0.040 max.	0.050 max.	0.18/0.25

Check analysis — Analysis of drillings taken from top of the first billet of the first and last ingots and the bottom of the last billet of the last ingot of each heat must come within the following limits:

C	Mn	P	S	Si
0.44/0.60	0.60/1.00	0.055 max.	0.055 max.	0.15/0.35

If any of the check tests were out of range, other billets were tested and discards made until all billets for use were within the specified analysis.

Etch tests — Test pieces were taken from the first, middle and last ingot poured of shell steel. These pieces were sawed from the top, middle, and bottom of billets rolled from the ingots to be tested. The test pieces were deep etched in hot 20 per cent sulphuric acid, dipped for a few seconds in 50 per cent nitric acid, scrubbed in water and then held in lime water at about 200 F until hot enough to dry from their own heat.

If any of these nine etch tests showed any degree of pipe, visible non-metallic inclusions, excessive segregation or porosity, it was rejected and other billets were tested and rejections made until only sound steel remained.

Test shells — A slug of suitable length to produce a 155 mm forging was cut from the top of the first billet of the first ingot and from the bottom billet of the last ingot of each heat. These slugs were marked for identity and forged into shells with the regular procedure. From each of these two specimens, a specimen was cut. After normalizing at 1600 F for 30 minutes, Brinell hardness tests were made, which could not exceed 223.

Two tensile test pieces were cut from the walls of the balance of the two test forgings, after heat treatment. These test pieces were required to meet the following specifications:

Yield strength at 0.0063 in. extension	Per cent elongation in 2 in.	Per cent reduction of area
65,000 psi	15	30

When all of the requirements mentioned above were met, the heat was released for forgings.

All completed forgings were required to pass the following inspection:

Visual inspection

1. Rough cavity
2. Scale
3. Seam
4. Sliver
5. Pits inside
6. Pits outside
7. Cracked boss
8. Cracked inside
9. Scored wall
10. Damaged by reamer
11. Lot number stamp

Gauge inspection

1. Short taper cavity
2. Long taper cavity
3. Long
4. Large inside diameter
5. Small inside diameter
6. Short
7. Base and boss thickness
8. Roundness of cavity

Any forgings failing to pass any of the above inspections could be thrown out, or be subject to further hospitalization.

HYDRAULIC EQUIPMENT

All of the forging presses and the descaler were operated by hydraulic water at 2500 psi.

The hydraulic power for No. 1 unit was supplied by two 475 gpm horizontal duplex plunger pumps, each driven by an 800-hp, 600 rpm, 2200 volt, 3 phase, 60 cycle, squirrel cage induction motor. Pressure switches located on a pneumatic-hydraulic accumulator bottle, with a capacity of 150 usable gallons, controlled the pumps through loading and unloading devices attached to the intake valves of the pumps. Additional pressure switches acted to prevent higher than normal water level in the accumulator, as well as excessive pressure, by stopping the pumps should these conditions occur.

The pumps and their controls for No. 2 unit were of a different design. Due to late deliveries, five plunger pumps of different design were provided, together with their controls. These pumps had a capacity of 270 gallons each at 2500 psi. The accumulator for these pumps consisted of 32 bottles standing vertically with 24 for air and 8 for water. The 24 air bottles were all connected together at the bottom through a manifold. The 8 water bottles were connected together at the bottom for water and at the top for air. The air manifold for the 24 air bottles connected to the top manifold of the 8 water bottles. The water manifolds at the bottom of the water bottles were connected to piping from the pumps and also to the piping serving the presses.

The controls for this system consist of 2 floats enclosed in 2 small float tubes. The top of each tube was connected to the top of the water bottle; the bottom of each is connected to the bottom of the water bottles. The floats are thin aluminum tubes of about 1½ in. diameter and about 15 in. long with a small iron disc attached to the top of each. These floats rise and fall with the water level inside the float tubes which are also of non-magnetic material. Coils of wire are located at intervals of about 6 in. around the float tubes. As the floats rise and fall with the water level, the iron cores or discs attached to the floats induce a small electric current as they pass through the coils. The coils are connected to relays in a cubicle which controls the current for loading and unloading the pumps. This control system also serves to shut the pumps down should higher than normal water level occur and to close low level valves should water in the accumulator fall to a level where there was danger of losing the air in the accumulator.

The controls were arranged to load and unload the five pumps consecutively. As the demand for water increased, the pumps picked up the load one at a time until all five pumps were loaded; likewise, as the demand receded, the pumps unloaded one at a time until when no water was being used all pumps were unloaded.

The space between the high and low level points on the float tubes was limited and the rise and fall of the water was rapid. Because of the large number of coils required for the control of all of the pump functions, it was necessary to use two float tubes in order to provide sufficient distance between the coils to assure positive action as the floats passed through the magnetic field of each coil. The float system of control is quite complicated and some of the electrical equipment is delicate. But after getting some of the faults out of the system, it gave satisfactory service.

The piping for the hydraulic systems in both No. 1 and No. 2 units was designed to hold the velocity of water to about 8 feet per second.

TOOLS

The life of the tools are an important factor in the economical production of shell forgings. These tools include such items as punches, dies, etc., and were so constructed that only the wearing parts required frequent replacement.

The following is a list of some of the more important tool items:

For piercing	For drawing
1. Pierce tips	1. Draw tips
2. Pierce shanks	2. Mandrel extensions
3. Die pot liners	3. Rollers
4. Knock out ends	
5. Stripper bushings	
6. Stripper rods	

Because of wartime restrictions, the procuring of tool steel suitable for making the tools, was quite difficult. The shortage of machine tools available for machining the forging tools also presented a formidable problem. The latter was solved by contracting portions of the machine work to shops in the district which were equipped to do a part of the work. The forging, heat treating and most of the final finishing as well as the redressing work was done in the T.C.I. company's shops.

The tool steel giving the best results for the punch tips, mandrels, etc., was produced by a local manufacturer and delivered in the shape of small ingots weighing about 600 pounds each. The per cent analysis of the steel was as follows:

For punch tips — 8.00 to 10.00 Cr; 0.30 to 0.60 Mn; 0.25 to 0.35 C; 1.00 to 1.50 Si; 1.00 to 1.25 Mo; 0.03 S max; 0.025 P max.

For punch shanks and mandrels — 4.00 to 6.00 Cr; 0.40 to 0.60 Mn; 0.15 C max; 0.40 to 0.65 Mo; low P; low S.

Knock out pins and die pot liners were made of steel produced in the open hearth furnaces of the Tennessee Coal, Iron and Railroad Company of the following analysis: 0.50 to 0.75 Cr; 0.70 to 0.80 C; 0.30 Mn max; 0.15 to 0.30 si; 0.03 S max; 0.025 P max.

The draw bench rollers were of chilled cast iron of the following analysis: Total C 3.39; combined C 1.35; Graphic C 2.04; Ni 1.00; Si 1.50; Cr 1.50; low S, low P.

PRODUCTION

The production of forgings with the equipment described above proved to be quite satisfactory. With both No. 1 and No. 2 units in operation, the monthly rate of production was 260,000 forgings. The rate per

hour varied. Individuals have clocked No. 2 unit when producing at a rate of more than 400 per hour.

The best 8 hour record of No. 2 unit was 2700 forgings. The best 24 hour record of No. 2 unit was more than 7000 forgings. The best one month record for No. 2 unit was more than 148,000 forgings.

No. 1 unit started in December 1941, was shut down July 13, 1945. No. 2 unit started in October 1944, was shut down August 15, 1945. The total number of forgings produced by both units was 5,790,251.

DISCUSSION

PRESENTED BY

P. J. BOWRON, Superintendent Annealing Department, Tennessee Coal, Iron and Railroad Company, Fairfield, Alabama

W. F. JONES, Engineer, Manufacturing Division, Tennessee Coal, Iron and Railroad Company, Ensley, Alabama

EDGAR A. HAWK, Fuel Engineer, Tennessee Coal, Iron and Railroad Company, Ensley, Alabama

P. J. Bowron: Mr. Jones stated that there was a rather large reduction in the weight of billets or slugs used — something like thirty pounds per finished forging. How was that achieved? Was it through a reduction in rejects, or by working the forging down closer to the finished projectile?

W. F. Jones: This reduction was obtained by reducing the diameter of the forging as well as its length.

P. J. Bowron: You worked to closer tolerances?

W. F. Jones: Yes. Because of the experience in World War I, when forging equipment was not so highly developed, forging tools were designed to produce forgings weighing 154 pounds. But with modern equipment and methods, it was found possible to forge to closer tolerances and produce forgings lighter in weight.

P. J. Bowron: You made that improvement right at the start?

W. F. Jones: The improvement was there, but we didn't take advantage of it right at the start.

Edgar Hawk: Two requirements in heating steel for forging are uniform temperatures and no scale. This is especially true in heating shells for forging. The slugs were heated in doughnut type rotary furnaces having both an inside and outside wall, similar to a circular tunnel. This design permitted burners to be located in both walls and provided better heat distribution across the hearth.

The slugs were charged on end and spaced four deep across the hearth. To heat the steel as fast as possible without overheating and allow ample time for soaking, the maximum fuel input per unit of hearth area was on the charge side of the furnace. At the discharge door, auxiliary burners were used to overcome heat lost through the door opening and provide any slight deficiency in heat to the steel.

With the slow rise in temperature toward the control point, the scale on the slug kept intact. Thus the reaction between steel and scale approached equilibrium, and, in approaching equilibrium, the scale, while holding its shape, tended to detach itself from the steel surface. When the slugs were drawn from the furnace and dropped onto the conveyor, practically all the scale was removed with the slug, but dropped from the slug before entering the scale breaker.

When the hearth was stopped, as during a mill delay, the burners in the first firing zone were automatically reduced to a minimum. This prevented overheating in the soaking zone. To maintain a uniform furnace pressure with variable rates of firing, an automatic furnace pressure control was used. This required a collector flue for the waste gases leading to a single outlet in the damper control. The fuel-air ratio control consisted of a common drive which actuated the gas and air volume for each zone.

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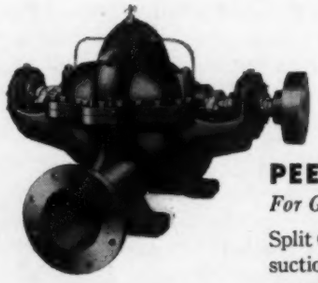

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by Norman J. Urquhart

FORT PITT BRIDGE COMPANY

CANONSBURG, PENNSYLVANIA

▲ IN 1943 the Fort Pitt Bridge Works, which is the owner of the Steel Processing Company, established a combustion research laboratory, and certain pilot furnaces were constructed which permitted thorough research and demonstration of theories of combustion. One of the developments stemming from this work is a one-way fired soaking pit that has neither regenerators nor recuperators. A few of these pits have been in service for several months. The results of their operation speak for themselves.

The pit design is a standard oblong box with its width, length and depth in proper ratio to the type and sizes of ingots which will be heated in the pit. The burner inlet and the flue outlets are located in the same wall on one of the narrow sides. The burner inlet port is so located that the propagated flame does not impinge on the steel ingots in the pit. The elimination of this impingement can be accomplished by either depth or width. The pit is so designed that when loaded there will be a net furnace volume equal to or more than twenty cubic feet per ton of metal charged.

The pit should be so constructed that a maximum of one and one-half inches water pressure can be maintained during high fire and a minimum of five one-hundredths inches of water pressure at low fire. The cover should be so constructed that the loss of heat through it should approach the loss of heat through the bottom as closely as possible. thereby reducing temperature variation from top to bottom of ingots to a minimum. The walls of the pit should, of course, be so constructed that a minimum of heat loss will occur. In the general construction, the exhaust ports should be connected to a stack or chimney which has practically no vacuum pull.

Having completed a chamber soaking pit of this type, next comes the method of firing automatically. This program of work is still being developed. There are five definite fuels that are available for soaking pit heating, namely, producer gas, natural gas, coke oven gas, powdered coal and oil, or any combination of them. So far we have been very successful with oil, natural gas and coke oven gas. At some plants the use of other fuel or fuels may be desired and it is our belief, from experiments in progress, that such other fuels can be successfully used.

In laying out a new soaking pit installation there are several features which must be taken into consideration:

1. Available area for pit furnaces.
2. Ingot handling.
3. Bottom making.
4. Fuel consumption.
5. Uniform heating.
6. Automatic control.

Under these headings will be discussed the performances of pits that are now in operation.

1. *Available area for pit furnaces* — A typical regenerative pit layout, and a layout of the new design of pits occupying an equal area are shown in Figure 1. The elimination of the checkers provides space for combustion equipment and permits enlargement of pit area to a very considerable extent. It is believed that by careful

Presented before AISE Annual Spring Conference, Chicago, Illinois, May 7, 1946.

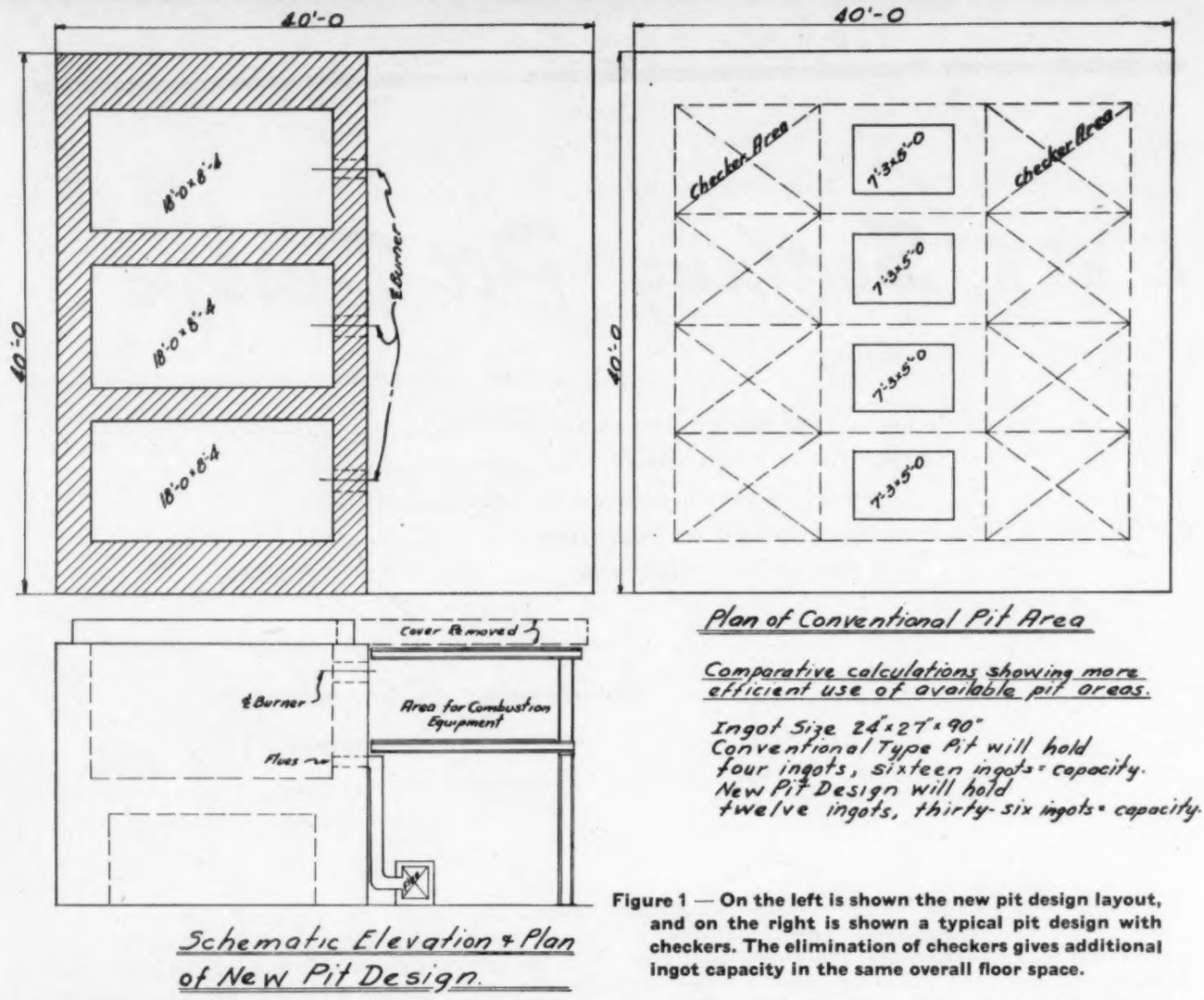
40'-0
40'-0
18'-0 x 8'-4
18'-0 x 8'-4
18'-0 x 8'-4
¢ Burner
Checker Area
Checker Area
7'-3 x 5'-0
7'-3 x 5'-0
7'-3 x 5'-0
7'-3 x 5'-0
Cover Removed
¢ Burner
Area for Combustion Equipment
Flues
Schematic Elevation & Plan of New Pit Design.
Plan of Conventional Pit Area
Comparative calculations showing more efficient use of available pit areas.
Ingot Size 24" x 27" x 90"
Conventional Type Pit will hold four ingots, sixteen ingots = capacity.
New Pit Design will hold twelve ingots, thirty-six ingots = capacity.

Figure 1 — On the left is shown the new pit design layout, and on the right is shown a typical pit design with checkers. The elimination of checkers gives additional ingot capacity in the same overall floor space.

planning ingot coverage can be increased one hundred per cent in the areas now occupied by present regenerative types of pits. As this area at the present time is a major bottleneck, the increased coverage obtained will allow for more careful heating of the steel.

2. *Handling* — The handling of ingots is not materially changed over present practice, except where it is possible to replan pit areas so that the ingot travels from the mold to the pit and from the pit to the ingot car over the same end of the pit.

3. *Bottom making* — Bottom making is a subject that may develop plenty of discussion, but where rolling temperatures are held to 2100 F and pit temperatures to 2400 F, cinder bottoms in our pit will give very satisfactory service. If higher finished rolling temperatures are desired, it is my opinion that research should develop a new type of non-fluxing bottom material. Operation of our pits have definitely shown that very little bottom making is necessary at average finished rolling temperature requirements.

4. *Fuel consumption* — The comparison of fuel consumption of our pit with a regenerative or recuperative type of pit necessitates a uniformity of ingots charged. Our pit will compare favorably where it is checked by such a comparison. In fact, on oil fired pits, tests showed that a recuperative pit was no more efficient than our direct fired pit.

5. *Uniform heating* — Our direct fired pressure pit heats the ingot uniformly on all sides because there is no secondary combustion occurring on the refractory walls of the soaking pit. Variations between top and bottom are dependent on the efficiency of the cover. At couple temperatures of 2400 F there is no excuse for washed surfaces.

6. *Automatic control* — Research work is going on at the present time and this work leads us to believe that a true picture of the internal as well as the external temperature of the ingot can be recorded. so that the operator will know definitely when the pit is ready for rolling without taking his cover off for visual inspection.

SUMMARY

We have found that there is no such thing as absolute uniformity of furnace operation and that from hole to hole each has its own peculiarities. Therefore, in the development of our work, we feel that it is necessary to make a definite analysis of each installation so that the whole installation will result in properly and uniformly heated steel in every day mill practice.

Further experimentation and research work in furnace and combustion development is now being made. Results of this work, which may be of interest and value to the steel industry, will be made available as soon as practical.

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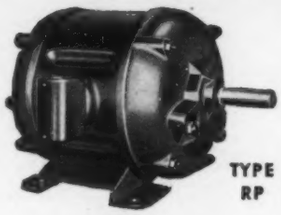

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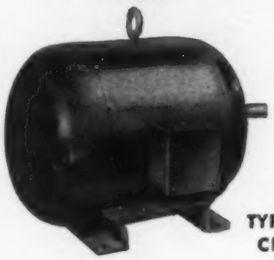

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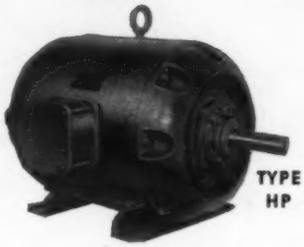

TYPE HP

TYPE TP

TYPE RS

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SINGLE-SPEED SQUIRREL-CAGE

TYPES	ELECTRICAL CHARACTERISTICS	APPLICATIONS
RP-1, CP-1, HP-1, TP-1.	Normal starting-torque—normal slip	Group or individual drives on machine tools, fans and blowers, compressors, centrifugal pumps—on any application where normal-torque motors are satisfactory.
RP-5, CP-5, HP-5, TP-5.	High starting-torque—normal slip	Crushers, plunger pumps, belt conveyors starting under load, large air-compressors, large refrigerating machinery, mixers, and other applications requiring high starting-torque.
RP-6, CP-6, HP-6, TP-6.	High starting-torque—high slip, punch press	Punch presses, shears, metal-drawing machines, balers, and other machinery equipped with flywheels or having flywheel effect.
RP-7, CP-7, HP-7, TP-7.	High starting-torque—high slip, elevator	Elevators, cranes, hoists, dumbwaiters.

TYPES	MECHANICAL CHARACTERISTICS	APPLICATIONS
RP-1, RP-5, RP-6, RP-7.	Open—ventilated	For applications where atmospheric conditions permit use of open-type motors.
CP-1, CP-5, CP-6, CP-7.	Totally-enclosed, fan-cooled	For locations where dust, abrasives, steel chips, filings, acid fumes, moisture, and other harmful elements are present.
TP-1, TP-5, TP-6, TP-7.	Totally-enclosed, nonventilated	
HP-1, HP-5, HP-6, HP-7.	Explosion-proof	For Class I Group D hazardous locations where gasoline, petroleum, naphtha, alcohol, acetone, lacquer, solvent vapors, natural gas, and other flammable liquids are manufactured or handled.

MULTISPEED SQUIRREL-CAGE

TYPES	ELECTRICAL CHARACTERISTICS	APPLICATIONS
MRP-1 to -7, MCP-1 to -7, MHP-1 to -7, MTP-1 to -7.	Two, three, or four speeds, in 3 types: Constant Horsepower, Constant Torque, Variable Torque	For applications involving two, three, or four speeds. Frames varied as listed under "Mechanical Characteristics", and electrically varied as listed under "Electrical Charactertistics" shown for single-speed motors above.

WOUND-ROTOR

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RS-1	General Purpose Continuous Duty	Conveyors, compressors, pulverizers, etc., requiring continuous operation.
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3. Greater economy due to better heat distribution; greater charging capacity and less radiation surface per ton charged.
4. All operational hazards eliminated.
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7. Ideally adapted to automatic control; always in natural balance.
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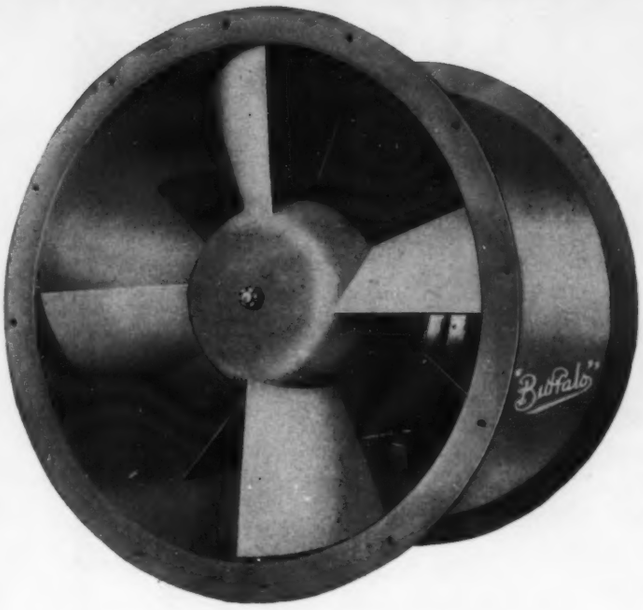

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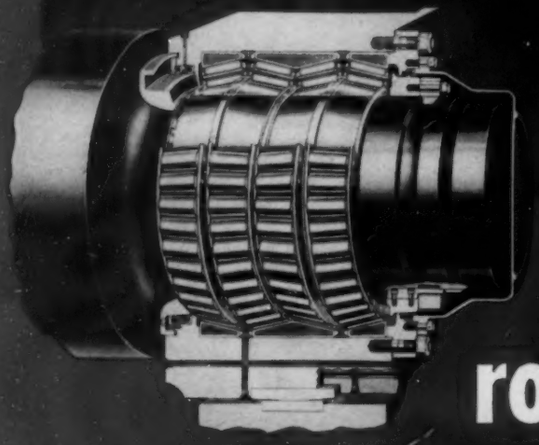

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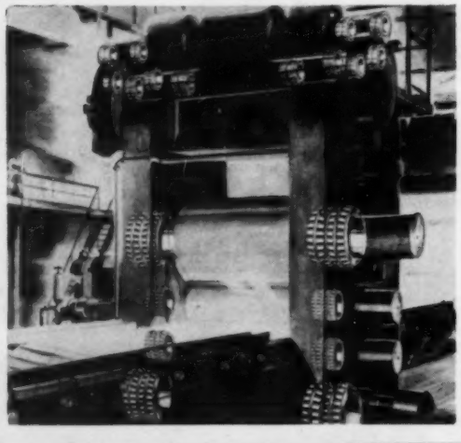

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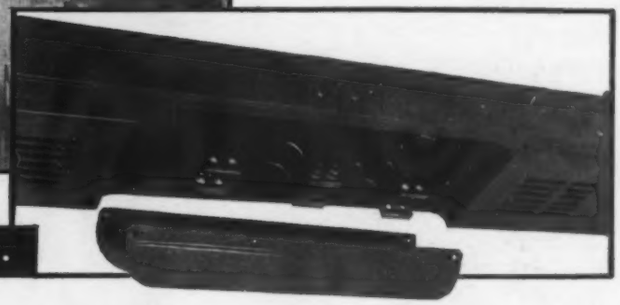

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If you are an electrical contractor, an architect, utility man, or industrial electrical engineer, here is something really important you can do for your customers or clients. Tell them about Trumbull's COMPLETE modern method and equipment for industrial and commercial power transmission and control . . . about Trumbull L.V.D. Busways for main feeder distribution . . . Flex-A-Power Plug-in Busways and Flex-A-Plugs for branch circuits to load, and Trumbull Control Centers for flexible, complete motor control and feeder circuits. Trumbull pioneered these basic systems. Trumbull engineering has brought them to their present high pitch of efficiency. And Trumbull production makes them available to you NOW in packaged units ready to install and connect.

If you are an industrial plant owner or operator faced with urgent need of procuring electrical power distribution equipment, call the nearest Trumbull Electrical Contractor right away, or write direct to Plainville.

THE TRUMBULL ELECTRIC MANUFACTURING CO.

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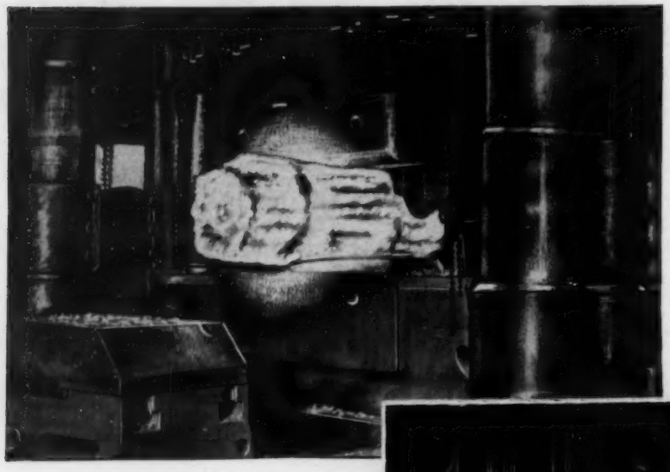
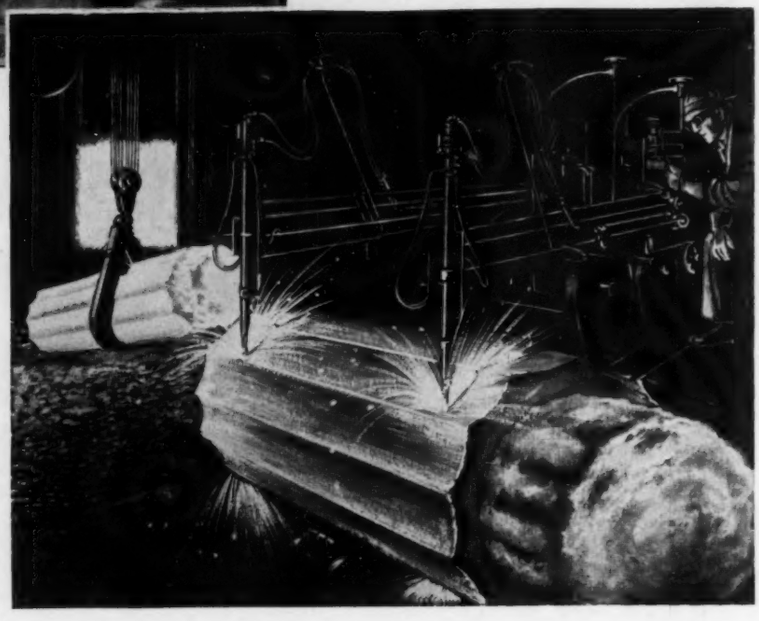
STILL LOOKING INTO THE FUTURE



YESTERDAY...

"Press Cropping" Ingots Was Advanced Technique. Until just recently, steel men used this method to crop or trim ingots preparatory to forging.



TODAY...

It's "Flame Cropping"! Now, hot tops and bottoms of large fluted ingots of even the toughest alloy steels are quickly and neatly cropped in one operation by an ingenious flame cropping machine. Developed by Airco as a service to the steel industry, this machine cuts operating time from hours to minutes...slashes costs . . . helps meet today's demands for high standards of quality.

and TOMORROW...?

Airco's research and development staff will continue to contribute to new and better ways of steel production with the same foresightedness that has always characterized their efforts to provide new tools for industry.

Airco's Technical Sales Division is at the call of steel men in applying Airco processes in the solution of their problems. For additional information, get in touch with your nearest Airco office or write: Air Reduction, 60 E. 42nd St., New York 17, N. Y. In Texas: Magnolia Airco Gas Products Company, Houston 1, Texas.

AIRCO AIR REDUCTION

Offices in All Principal Cities

ORIGINATORS OF MODERN OXYACETYLENE METHODS FOR THE STEEL INDUSTRY

for high-speed motors

AFTER extensive field tests, Speer Carbon Company offers a new carbon brush—grade No. 4029—developed expressly for use on industrial high-speed motors and Diesel-driven generators. Here are the advantages that make this Speer brush outstanding:

- Exceptionally wide band of commutation
- High stability in operation
- Test-proved dependability
- Long service life
- Reduces commutation wear

This new Speer brush also gives superior performance on generators and traction motors in both road and switcher types of Diesel-electric locomotives. It is available in a standard single-piece brush or in the Speer "Multiflex" construction. Send for complete data today.

"You have developed a powerful new brush in No. 4029, and in the 'Multiflex' type."

"You have given us a great advance in brush assembly."

"Saves commutators and reduces commutator maintenance."

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MILWAUKEE • NEW YORK • PITTSBURGH

SPEER
CARBON COMPANY
ST. MARYS, PA.

Philco "Thirty" Industrial Truck Storage Battery gives 30% longer life and is identified by its distinctive rod connectors.

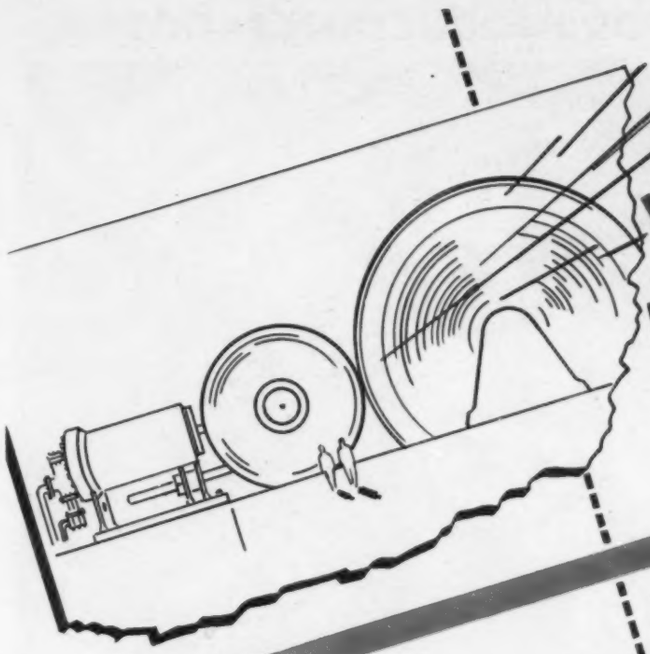
FOR 50 YEARS A LEADER IN INDUSTRIAL STORAGE BATTERY DEVELOPMENT

PHILCO CORPORATION • STORAGE BATTERY DIVISION • TRENTON 7, NEW JERSEY

MODERN ELECTRIC INDUSTRIAL TRUCKS POWERED BY COST-SAVING PHILCO "THIRTY" STORAGE BATTERIES

Now you can get the kind of industrial trucks experience has proved the safest, most flexible and maintenance-free—ELECTRIC TRUCKS! And you can power your trucks with the greatest materials handling development since the fork-lift truck, itself—PHILCO "THIRTY", the Storage Battery with 30% longer life! Plan now for the big demands increasing production will place on your materials handling equipment. Philco "Thirty" will give your trucks top capacity, *plus* savings in maintenance, depreciation and replacements. Write today for new catalogs giving specifications.

PHILCO *Famous for Quality the World Over*

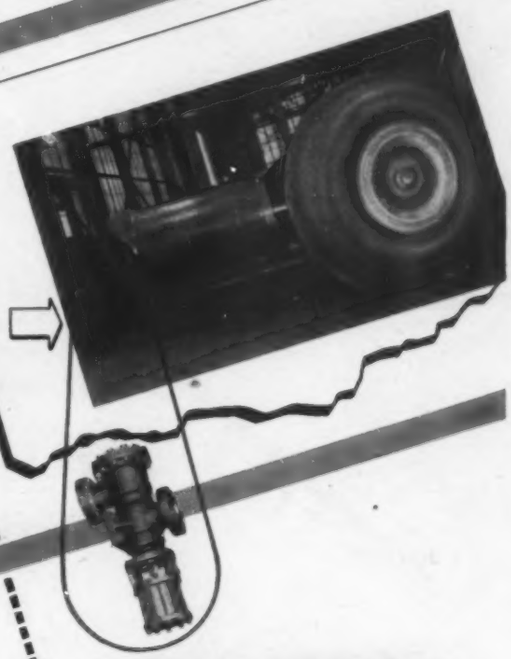


WHAM!

500 pounds of Compressed Air Smacks Giants Together

Large 6" Quick-As-Wink Valve Handles 500 Pound Air

Three Quick-As-Wink valves help control the 500 pound air pressure needed for this inertia brake and tire testing machine. The 6" valve controls a single acting cylinder . . . a 3" valve exhausts the 42-inch cylinder, which is then returned by applying 200 lbs. of air to small pull-back cylinders through a 2" single plunger valve.



This inertia brake and tire testing machine assimilates conditions of a loaded bomber or passenger transport coming in for a landing.

To explore the effects of heat and pressure of the tremendous impact when wheel hits runway, this machine applies the tire to the spinning 16 foot flywheel.

The setup requires 500 pound air pressure applied to a single acting air cylinder of 42" diameter by 50" stroke. To control the extreme pressure, C. B. Hunt & Son, Inc. designed and built a 6" air valve . . . an unusual valve handling 500 pound air pressure.

Adamson-United Co., Akron, Ohio, which engineered and built the brake and tire testing assembly for Wright Field, Dayton, Ohio called in C. B. Hunt & Son, Inc. to recommend and construct the proper type of valve.

We manufacture solenoid, hand, foot and diaphragm operated air valves, and a complete line of hand and pilot operated hydraulic valves for water and oil. We make a full line of hand and pilot operated hydraulic valves for pressures as high as 5000 pounds.

Quick-As-Wink
HUNT CONTROL VALVES

C. B. HUNT & SON, INC., SALEM, OHIO

Send for the new Quick-As-Wink valve bulletin. It's full of factual data.

LOOK TO THE FUSE LEADER FOR PRODUCTION PROGRESS

WARE
HI-LAG
Renewable
FUSES

Double Fibre Bridge Assembly Increases Strength 10 Times

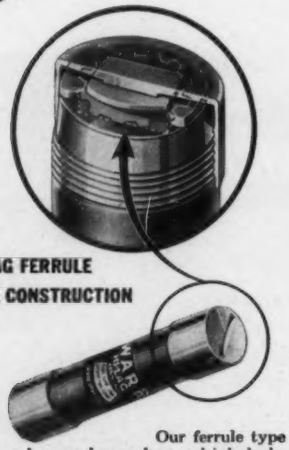
WARE HI-LAG Fuses have the strongest, most rigid knife blade assembly ever designed in fuses. The two heavy fibre bridges are supported by sturdy brass brackets which add greatly to the strength of the assembly. These bridge supporting brackets are attached to the copper knife blades and contact the entire end of links so that current flows through the brackets as well as the blades over a large area. Another reason for WARE HI-LAG Fuse's cool operation.

Perfect alignment is always maintained in this knife blade assembly with links centered in casing. The links are quickly and easily replaced or removed by loosening the nuts and slipping in or out.

Start using WARE HI-LAG Fuses today! Make them Standard Equipment for greatest economy and satisfaction. Investigate *now!*

Write for Brochure giving details of all the COOL FACTS, sizes and prices

APPROVED BY UNDERWRITERS' LABORATORIES



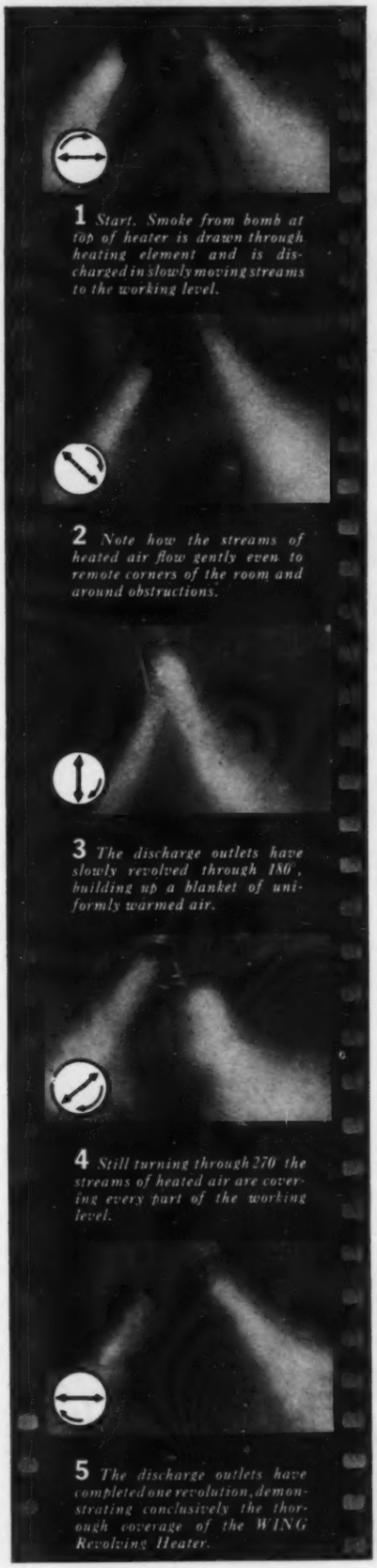
HI-LAG FERRULE FUSE CONSTRUCTION

Our ferrule type fuse has a heavy brass bar, which locks into open end ferrule, bridging fuse case. This bridge locks link to prevent twisting and cap tightens on new center contact. No sagging washers or twisted links to cause overheating.

WARE *Brothers* 4450 W. LAKE ST.·· CHICAGO 24, ILL.

THE MODERN HEATING SYSTEM FOR FACTORIES

Pictures below are from continuous exposures made during a Smoke Test of WING Revolving Unit Heaters



1 *Start. Smoke from bomb at top of heater is drawn through heating element and is discharged in slowly moving streams to the working level.*

2 *Note how the streams of heated air flow gently even to remote corners of the room and around obstructions.*

3 *The discharge outlets have slowly revolved through 180°, building up a blanket of uniformly warmed air.*

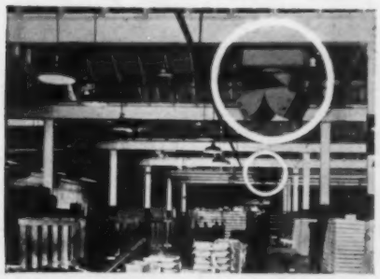
4 *Still turning through 270° the streams of heated air are covering every part of the working level.*

5 *The discharge outlets have completed one revolution, demonstrating conclusively the thorough coverage of the WING Revolving Heater.*

WING *Revolving* UNIT HEATERS

DO WHAT NO OTHER FORM OF PLANT HEATING CAN DO

Not just another unit heater, the WING REVOLVING HEATER is unique in that it does what no other heater can do—its slowly revolving outlets gently distribute the heat continuously in a constantly changing direction. It reaches over, around and under obstructions into out-of-the-way corners, its moving streams of heated air quickly warm up a plant in the morning and its properly warmed, healthful air currents thoroughly distributed, create a sensation of live, invigorating comfort for the workers. Wing Revolving Unit Heaters are used in many of the country's leading industrial plants. Write for a list of installations.



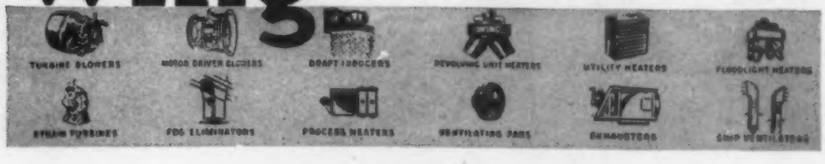
Above: Wing Revolving Unit Heaters in a typical low ceiling type of installation. Revolving Heaters are also made for practically any height roof or ceiling.

K COMPLETED
WING
MAKES WORKERS FEEL COMFORTABLE, LIVE AND INVIGORATED—MORE PRODUCTIVE . . .
WING
TOOL ROOM
REACHES OVER AND AROUND OBSTRUCTIONS AND INTO OUT-OF-THE-WAY CORNERS . . .
7:30 A.M. HEATERS TURNED ON
WING
8 A.M. PLANT COMFORTABLY HEATED
MOVING DISCHARGE HEATS UP PLANT QUICKLY
WING
REDUCES ABSENTEEISM DUE TO COLDS RESULTING FROM DRAFTS, CHILLS OR OVERHEATING
WING
IS AN EXCELLENT COOLING SYSTEM IN SUMMER WITH STEAM OFF AND FANS ON

L. J. Wing Mfg. Co.
154 West 14th Street
New York 11, N. Y.

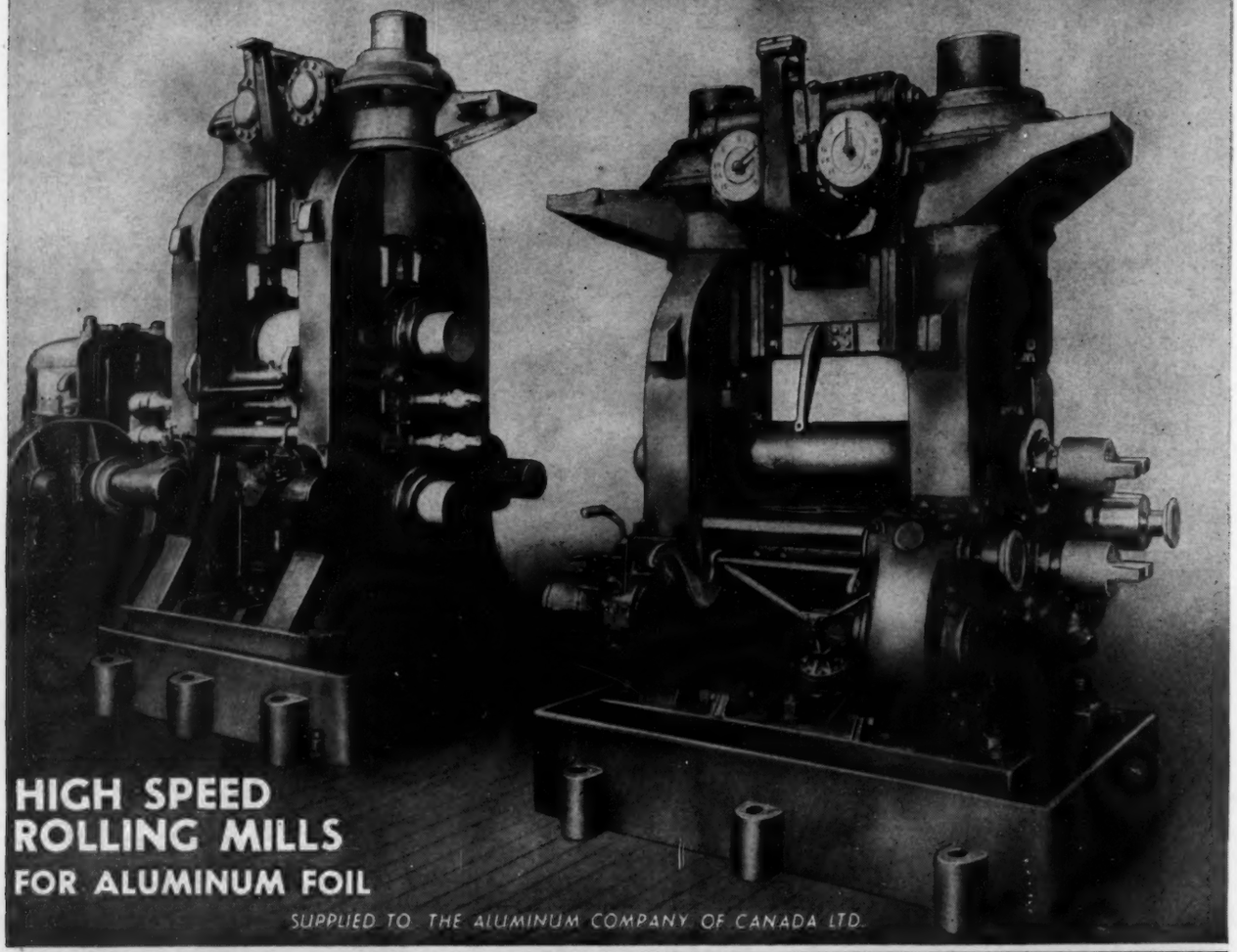
Factories at Newark, N. J. and Montreal, Canada

Wing REVOLVING UNIT HEATERS



ROLLING MILLS AND ROLLING MILL EQUIPMENT

FOR FERROUS AND NON-FERROUS METALS



HIGH SPEED
ROLLING MILLS
FOR ALUMINUM FOIL

SUPPLIED TO THE ALUMINUM COMPANY OF CANADA LTD.

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NEWS SUPPLEMENT July, 1946

Equipment
Personnel
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Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

WHEELING STEEL CORPORATION PLANS MODERNIZATION PROGRAM AT MINGO

▲ Wheeling Steel Corporation has announced preparation of plans for modernization and expansion in the Wheeling district, particularly at its newly acquired Mingo, Ohio, property recently purchased from the Carnegie-Illinois Steel Corporation. This property is adjacent to its Steubenville, Ohio, works. It is estimated that the contemplated improvements over a period of years may involve the expenditure of as much as 50 million dollars at Mingo, Steubenville, East Steubenville, Yorkville, and the Wheeling district.

Announcement was also made of the sale of the Portsmouth, Ohio, plant to the newly formed Portsmouth Steel Corporation. Operations at Portsmouth will be continued without interruption by the new owner.

The Mingo plant property comprises some 156 acres with approximately 5000 feet of river front with modern docks. Present equipment consists of three blast furnaces, two Bessemer converters, two hot metal mixers, numerous mill buildings, cranes and auxiliary equipment adapted to iron and steel manufacture.

In addition to modernizing existing facilities, Wheeling plans to construct additional coke ovens, and open hearth furnaces, with necessary rolling mill equipment, and to inter-connect the Mingo plant with its Steubenville and East Steubenville plants.

The close physical relationship of the three properties will obviously make for a well balanced and highly integrated production of the light steels in which Wheeling specializes. Also obvious is the close physical tie-up by rail and river with Wheeling's important Yorkville works where Wheeling initiated and proposes to expand its production of tin mill products.

Upon completion of its expansion program and eliminating tonnage formerly produced at Portsmouth, Wheeling Steel expects to emerge with an annual ingot capacity in excess of two million tons.

The reduced cost of production and other economies obtained as a result of its expansion program, should materially improve Wheeling's competitive position and increase its earning power.

EATON GROUP FORMS NEW STEEL COMPANY

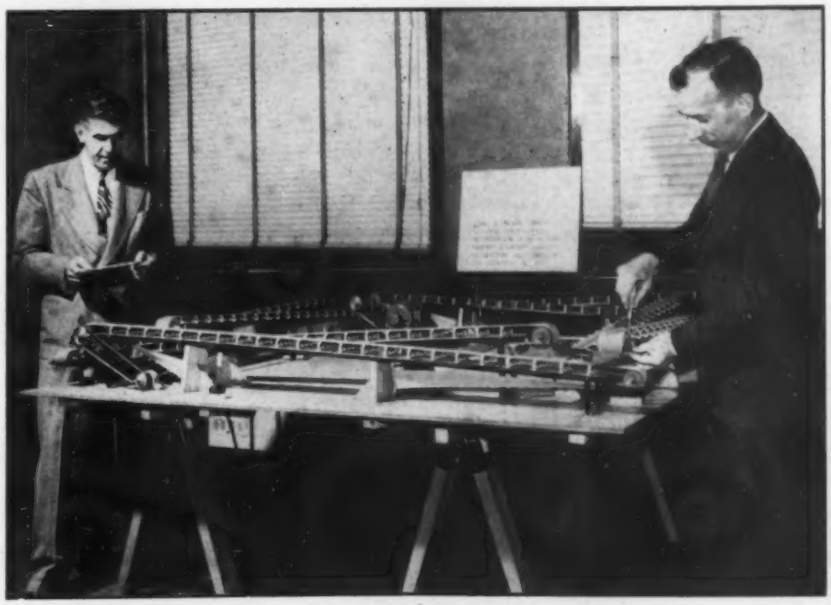
▲ Cyrus S. Eaton, Cleveland industrialist and one of the nation's leading bankers, announced that he and a group of associates, including William R. Daley, president of Otis and Company, have organized a new steel company known as the Portsmouth Steel Corporation to acquire the Portsmouth works of the Wheeling Steel Corporation at Portsmouth, Ohio.

In a registration statement filed with the Securities and Exchange Commission, it was revealed that the Portsmouth Steel Corporation, which was incorporated on May 23, would issue 1,025,000 shares of common stock to the public at $10 per share. Underwriters of the new issue will be Otis and Company of Cleveland.

Mr. Eaton also announced that an additional 300,000 shares of the common stock of Portsmouth Steel would be issued. Kaiser-Fraser Corporation has agreed to purchase 200,000 of these shares and Graham-Paige Motors

WORLD'S FIRST TWO-WAY CONVEYOR BELT —I-34—

Introduction of the world's first two-way conveyor belt highlighted the recent conference held by the mechanical goods division of the Goodyear Tire and Rubber Company. Designed by C. F. Smith (left) of the belt engineering sales department, these four miniature two-way conveyors illustrate the newest principle in handling bulk materials. The belts are installed in a manner that permits each belt to carry material on the "return run," thus continually utilizing the top cover of the conveyor.



Corporation 100,000 at the public offering price. The new steel company has contracted to provide the two automobile companies with part of their requirements of sheet steel for Kaiser and Frazer cars.

The registration statement also revealed that the purchase price of the properties that Mr. Eaton and his associates are acquiring from Wheeling Steel would be $12,000,000. For this amount Portsmouth Steel will acquire Wheeling's present Portsmouth works, the Emperor Coal Company of Kentucky, the Portsmouth inventories and work in process, and working capital.

The Portsmouth Steel Corporation will have a capacity of approximately 50,000 tons of steel ingots per month, and will engage in the manufacture of a variety of steel products including ingots, slabs, sheet bars, tie plates and wire products.

The steel sheets for Kaiser-Frazer and Graham-Paige will be rolled for the new steel corporation by Wheeling Steel in Steubenville, Ohio. Under the sales agreement with the motor car manufacturers the steel company will provide them with a substantial portion of their requirements for automobile sheet.

The Portsmouth works covers approximately 190 acres of land and includes a by-product coke plant with an annual capacity of approximately 450,000 tons; a blast furnace with a capacity of about 285,000 tons; 10 open hearth furnaces with a rated capacity of approximately 612,000 tons; mill equipment for producing semi-finished steel; a rod mill with a 192,000 ton capacity; a wire mill and a number of other units including iron, steel and brass foundries.

Mr. Eaton, who will be chairman of the board of the new steel corporation, has long been a leading figure in the steel industry. He organized the Republic Steel Corporation, and is a director of the Cliffs Corporation which, with its subsidiary the Cleveland-Cliffs Iron Company, has substantial stockholdings in Republic Steel Corporation, Inland Steel Company, Youngstown Sheet and Tube Company, Jones and Laughlin Steel Corporation and Wheeling Steel Corporation. Mr. Eaton is also a director of the Chesapeake and Ohio Railway, the Sherwin-Williams Company, William Whitman Company, Inc. and Steep Rock Iron Mines, Ltd.

CRANE CAB COOLING

By B. B. REILLY

DRAVO CORPORATION

▲ Recent developments and improvements in the art of air conditioning crane cabs and control pulpits in the steel mills have raised the question of where and how to draw the line in determining which cabs shall be cooled and which shall not.

Since the spaces under consideration are generally occupied by only one or two men at a time and the mechanical complications encountered in air conditioning these spaces are great, the investment per man for air conditioning is rather high. The idea of air conditioning for comfort alone therefore seems out of the question. It would appear that the only considerations could be safety and health.

I DESIRE MORE INFORMATION

Included in this section is a coupon which can be used by you in obtaining additional information on any article that appears in the News Supplement. At the close of each item, on which information is obtainable, appears a key reference number (Example: E12 or NEB56). Simply mark the reference number on the coupon, complete your address data and return to us.

Safety, primarily, because the lives of many men depend upon efficient operation of certain cranes and control pulpits.

The question then seems to resolve itself into determining which crane cabs and which pulpits are subjected to temperature dangerous to human efficiency and health, or just what can be considered a dangerous temperature condition.

The American Society of Heating and Ventilating Engineers has sponsored an intensive program of investigation to determine safe limits of atmospheric conditions for workers in industry. The physiological theory and data included herein has been largely based upon reports published in the A. S. H. V. E. Transactions regarding this program of investigation.

The theory advanced as a result of these investigations is that heat exhaustion in healthy individuals is quite normal and to be expected at high atmospheric conditions. The human body is a heat generator — the rate of heat generation depending upon the degree of activity. Further, a constant body temperature, or normal temperature, appears necessary. Consequently, heat must be dissipated from the body at the same rate as it is generated. This heat balance is maintained by means of the blood streams of the body and their intricate controls which tend to divert greater volumes of blood to the body surfaces for cooling as the body temperature tends to rise. This cooling at the body surface is aided by increased perspiration so that evaporative cooling of the skin is achieved. As atmospheric temperatures continue to rise, however, a point is reached where this body cooling system is inadequate and the body temperature cannot remain at normal but must rise.

In an effort to counteract the increased body temperature, excessive blood volumes are diverted to the surface blood vessels, so that there is an insufficient return to the heart and fainting or heat exhaustion results. This condition will develop in spite of adequate intake of water and salt. However, prolonged exposure to more moderate conditions without proper intake of water and salt produces similar effects by dehydration and

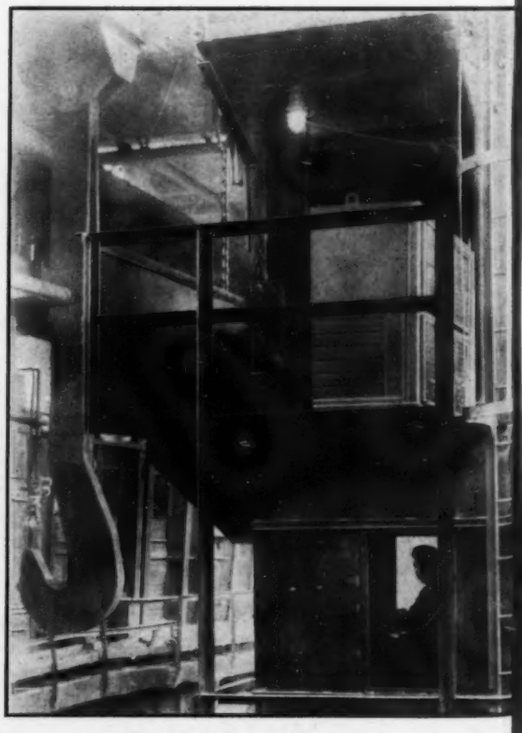


Figure 1 — Crane cabs should be cooled not for comfort of operator but for safety and health of many men.

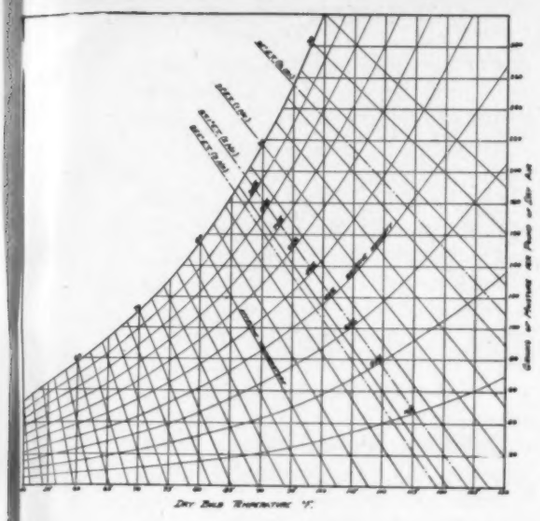


Figure 2 — Above is a standard pschrometric chart showing effective temperatures. The lines are indicated through points of approximately the same effective degree of comfort as determined by experiment.

reduction of sodium chloride concentration due to excessive perspiration. For present purposes it is assumed that sufficient water and salt are absorbed.

Since evaporation from the body surface plays such an important part in maintaining normal body temperature, and since the rate of evaporation varies appreciably with air humidity at any air temperature, it is necessary to consider both humidity and temperature in determining the limiting point above which heat exhaustion may be anticipated. The A. S. H. V. E. Effective Temperature Chart (Figure 2) is a standard Psychrometric Chart with lines indicated through points of approximately the same effective degree of comfort as determined by experiment.

Tests on a number of subjects indicate that the time factor is very important with respect to resisting high temperatures. For an average allowable increase in body temperature of ½ F above normal, under light working conditions, it was found that effective temperatures of 95 F, 90 F, 87.1 F, 85.6 F could be endured for ½, 1, 2 and 3 hours respectively. These conditions are suggested as maximum safe limitations.

Thus, there are three principal factors involved in determining whether or not air conditioning is required — surrounding air temperature, humidity, and length of time the workman is subjected to these conditions. Using the above conditions as a basis, it should be possible to check each cab considered for air conditioning during hot summer weather to determine whether or not the normal conditions in the cab fall above or below the safe limit for the length of occupancy required.

Since most of the "hot spots" in the steel mills are subject to intense radiation from hot metal, it is important that any temperature measurements taken indicate not only the air temperature but the radiating effect upon the workmen due to hot metal in the vicinity. Also, since there are often wide variations in the intensity of these radiations, it would appear more practicable to use recording instruments with the thermostatic elements exposed to approximately the same conditions as the workmen's bodies. An hour or two check at any one station should give an adequate indication of whether or not the operation falls above the safe limit for human occupancy. —E-24—

IS HEAT SLOWING UP YOUR WORKMEN?

TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep Them COOL with TRUFLO FANS

TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY
554 MAIN ST., HARMONY, PA.

CHIKSAN

Straight flow

FIRE MONITOR

OTHER USES: Hydraulic Washing Equipment, Log Debarking, Mixing Equipment. Can be supplied with any type of nozzle required.

For *complete, fool-proof* fire protection, install CHIKSAN *Non-Spin* Fire Monitors at strategic locations. Easy turning is provided by double rows of ball bearings, permitting the Chiksan Fire Monitor to be turned full 360° in both horizontal and vertical planes. Monitor can be locked in any desired position. Since the discharge flow is in the same plane as the supply line, the Chiksan Fire Monitor will not spin. This means greater safety to the operator. Nothing to tighten or adjust. The Chiksan Fire Monitor is ready for instant action all the time.

Write for latest catalog.

CHIKSAN REPRESENTATIVES IN PRINCIPAL CITIES
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BRANCHES: New York 7, Houston 2

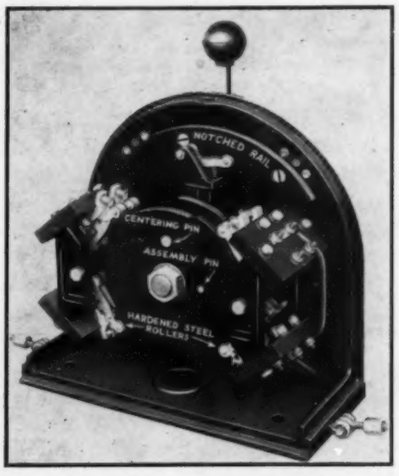
CHIKSAN TRADE MARK REG. BALL BEARING SWIVEL JOINTS FOR ALL PURPOSES

CHIKSAN COMPANY
BREA, CALIFORNIA
New York 7 Houston 2

MASTER SWITCH FOR MAGNETIC CONTROLS

▲ For use with mill and crane magnetic controllers, the Type CM master switch is announced by the Electric Controller and Manufacturing Company.

The CM master switch is of the cam type, having silver alloy contacts normally spring-closed and opened by 7-inch diameter cams. The use of large diameter cams results in a saving in motion by the operator (short throw — only 37½ degrees for a 6 speed-point switch), reduces mounting space required when several switches are installed in a mill pulpit or crane cab (narrow width — 8-circuit masters can be mounted on 7⅞-inch centers), making it easy for



an operator, without changing his position, to conveniently reach and operate them.

Cams are mounted on the shaft and keyed in position by a centering-pin, screwed into the keyed roller arm bracket. The assembly-pin identifies the arrangement of cams for right or left hand operation. The notched centering-device rail contributes to smooth and easy operation, and is so located that increased roller-spring pressure is automatically obtained as the lever-arm is advanced to the full-on position.

—E-25—

ARMCO BUILDS MODERN COKE OVEN IN OHIO

▲ The American Rolling Mill Company will construct 25 new coke ovens at its Hamilton, Ohio, plant at an estimated cost of $1,275,000. In addi-

tion, the company will spend $300,000 repairing existing ovens.

The Koppers Construction Company has been awarded the construction contract. Work will be started within a few weeks and it is anticipated that the new ovens will be in operation next April.

When the new units are completed the number of ovens in the battery at Armco's Hamilton plant will total 110. The company is making the addition to increase its supply of coke which is used in making pig iron.

NEW METAL CLEANERS NOW IN PRODUCTION

▲ First production of two new products, Pennsalt Cleaner A-22 for aluminum alloys and PM-95, an acid base cleaning and descaling compound, were announced by the Pennsylvania Salt Manufacturing Company.

Pennsalt Cleaner A-22 is a general purpose soak tank cleaner for use on all aluminum alloys. Most common applications are cleaning aluminum before anodizing, chromodizing, phosphatizing and other pre-painting treatment and before deoxidizing and subsequent spot welding.

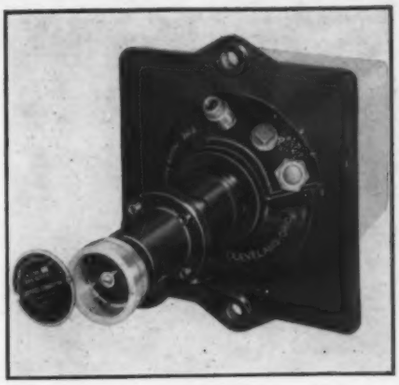
Pennsalt PM-95 is a specially prepared cleaning and descaling compound containing additional agents for surface action and inhibition. Suggested uses are general pickling and metal descaling, especially for difficult-to-remove oxides resulting from heat treating or annealing.

—E-26—

PRESET AIR-GAS RATIO IN COMBUSTION BURNER

▲ Recently announced was a new certified combustion industrial gas burner offered by The North American Manufacturing Company.

The new piece, designed for industrial use, combines a novel group of valuable characteristics never heretofore combined in one burner. Most valuable of all to many users of burners, it affords factory presetting of the air-gas ratio to allow positive initial light-up of one or more companion burners in actual field service. Such is possible when the factory is informed of the gravity and unit thermal content of the gas to be used. In the event of a subsequent change of gas used, it is only necessary to remove the adjustment cover plate and move the indicator vane to the dial position marked for the Btu value of the new gas.



In event of subsequent change of gas used it is only necessary to remove adjustment cover plate and move the indicator vane.

Similarly, other air-gas ratios may be had by changing the indicator vane position to definite dial locations readily obtained from the simplified table and instructions on the reverse side of the cover plate. Tabled data allow for variations of ratio from 80 to 105 per cent of theoretical air content in the air-gas mixture obtained.

Another feature, probably most valued by many other prospective users of the certified combustion burner is the provision for exceptionally deep turndowns. Mixture of fuel and air is initially affected at the outer tip of the burner nozzle and completed within the burner tile. Turndowns therefore are limited in scope only by the sensitivity of the atmospheric regulator in its ability to follow a decreasing air flow through the burner with an accurately proportioned gas flow. No flashbacks can therefore occur at any time or at any degree of turndown.

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IRON AND STEEL ENGINEER

1007 EMPIRE BUILDING, PITTSBURGH 22, PENNSYLVANIA

WHEN you buy Roller Conveyer, keep in mind the service that you should expect from it. While two sections of different manufacture may appear to be of identical design, actually there is probably a vast difference in them. The gauge and quality of tubing used — the design of the bearings and the method of their lubrication. The size and style of axles, and the method of securing them in frames. The construction and cross-bracing of the frames. The couplings and supports. The weight and strength of the section. These are points which should be considered important. They quickly show that there is a difference in Roller Conveyer.

There is 40 years' experience behind Mathews Roller Conveyer. It is engineered to give long, efficient service, and each section is designed to meet specific customer requirements. We will gladly mail you complete data without obligation.

MATHEWS CONVEYER COMPANY
ELLWOOD CITY, PENNSYLVANIA
SAN FRANCISCO, CAL. • PORT HOPE, ONT.
ENGINEERING OFFICES IN PRINCIPAL CITIES

It has been demonstrated that deviation in CO_2 composition of the flue gases was within one per cent.

The burner operates on a 24 ounce blower and over the extremely wide turndown range from 350,000 Btu/hr maximum to 20,000 Btu/hr minimum. It has been demonstrated by a concurrently indicating Weaver meter on the furnace that the deviation in the CO_2 composition of the fluegases from the burner was within 1 per cent over that wide operating range. A soft seat atmospheric gas regulator also made by The North American Manufacturing Company controlled the fuel.

Simplicity of control is another salient feature of the certified combustion burner. Mixing characteristics explained in the second preceding paragraph place the burner definitely in the nozzle mixing class. It has, however, none of the undesirable characteristics of the usual nozzle mixing burner. Gas at low pressure may be used since its entrainment is Venturi controlled from an atmospheric fuel regulator. Capacity variation is therefore a simple matter of air control only, by either manual means or any of the various types of pneumatic or electric automatic operators. The several attendant ills of impulsed fuel regulation are thus circumvented.

The certified combustion burner is marketed as a complete unit of mixer, burner, mounting plate and tile. Provisions are made for mounting a spark or manually ignited pilot tip on the

mounting plate. A second aperture allows for compactly mounting a flamerod to contact the junction of pilot and main flame for automatic protection devices. Observation of this junction is permitted through a removable hex-mounted lens.

Adjusted for theoretical fuel-air ratio, the flame lengths developed extend very little beyond the tunnel mouth. The burner therefore immediately becomes ideally adapted to all applications where the quiet, safe and precision-ratio features of a sealed-in, premix type flame are capital. Such uses would include forging, heating, and metallurgical furnaces, ceramic kilns, direct or indirect fired ovens, and in fact installation varieties numbering legion.

—E-27—

ROLL FIRM OFFERS TO SELL STEEL FOUNDRY

▲ The officers and directors of the National Roll and Foundry Company, Avonmore, Pennsylvania, recently voted to discontinue operations in the steel foundry and to concentrate all future activities on the production of iron rolls. The steel foundry plant and equipment is to be offered for immediate sale.

In explaining this action, W. H. Seaman, president, stated that prior to the war the steel foundry had been inactive but was rehabilitated to handle the production of urgently needed tank armor and artillery castings. Now that the emergency is over, the decision has been made to revert operations to a peacetime basis and to devote full time and effort to the regular line of iron rolls that, since 1909, has been the company's basic product.

—E-28—

SOLENOID CONTROLS SMALL POPPET VALVE

▲ A new valve has just been introduced by the Ross Operating Valve Company. It is the Ross piston poppet, pilot operated, solenoid controlled air valve. The valve is comparatively small, compact, and rugged in construction. The new valve allows operating speeds up to 400 cycles per minute, with current consumption 1.2 amperes at 110 volts 60 cycles.

All working mechanisms are interchangeable; simply removing the two end plugs allows for replacement of

NEW EQUIPMENT BRIEFS

Floodlight front glass can be spun onto a reflector to form a permanent weatherproof seal eliminating need for hinged door. General Electric Company. NEB 1.

▲ ▲

Aluminum bar stock of 3/8 in. diameter can be used for fabricating into pliers, tongs and special hand tools. Reynolds Metal Company. NEB 2.

▲ ▲

Microwave tubes, smaller than standard radio tubes, may be used with relatively simple waveguide systems and built into production lines for inspection and control operations. Sylvania Electric Products, Inc. NEB 3.

▲ ▲

Portable tool can be used for installing coaxial and shielded cable connectors. It is easy for the operator to insert cable and connector. The complete connection is then made by a single stroke of the tool. Burndy Engineering Company. NEB 4.

▲ ▲

Thermosetting silicone resin has been developed for use in formulating exceptionally heat and moisture resistant paints that do not become yellow or chalky with age. Dow Corning Corporation. NEB 5.

▲ ▲

"Griptred" is a non-slip safety flooring and protective covering material for metal, wood and concrete. Two million strokes by stiff power driven brushes on the covering applied to steel plate submerged in soap solution had no effect on the material. Goodyear Tire and Rubber Company. NEB 6.

▲ ▲

Coil winder drive for fractional horsepower motor winding has a simplified operation with only two controls and a clutch in obtaining a speed variation of 41 to 410 rpm. Ideal Industries, Inc. NEB 7.

▲ ▲

Unloader, for use with lift trucks, is hydraulically operated by the driver. Two double acting hydraulic cylinders move vertical rack forward, pushing the load off forks. Towmotor Corporation. NEB 8.

▲ ▲

A new heavy duty hole and washer cutter for production work cuts clean round holes or washers from steel plate, or any other material up to 1/2 in. thickness. Wyzenbeek and Staff, Inc. NEB 9.

▲ ▲

Two new types of tools having clamped-on advanceable Kennametal tips are now in production. The tips for these new tools can be supplied with permanent, molded-in chip breaker, constant in depth, but adjustable in width by varying the amount ground from end, or side cutting edges. Kennametal, Inc. NEB 10.

▲ ▲

A seam welder has a stationary welding head and the work moves under the head in a continuous stream making a straighter weld. The unit has a variable speed range of 60 to 150 in. per min, with reversing and inching controls. The speed can be altered while the work is in motion. Victory Engineering and Machine Works, Inc. NEB 11.

▲ ▲

No-Fog is now sold in collapsible tubes for the prevention of fogging and steaming of goggles and gas masks. It is a non-abrasive cream applied to both sides of lenses, after which the lenses can be polished to an invisible finish with cloth. Carhoff Company. NEB 12.

▲ ▲

Positive prints may be made direct from engineers drawings and tracings without the use of a negative. A dry direct process of development, with no wet chemicals, quickly produces prints that are flat and true to scale. J. H. Weil and Company. NEB 13.

▲ ▲

Carbide tipped threading tools of the 60 degree v-nose type are particularly suitable for long run threading of steel parts. Primary clearance at nose is 3 degrees and secondary clearance is six degrees providing free cutting with ample nose support. Carboloy Company, Inc. NEB 14.

▲ ▲

Folding steps for trucks, installed with four bolts on truck rear, fold under the truck bed. When simple trip is operated two sturdy 16 in. steps swing down and lock in open position ready for safe use. These steps will reduce hernia causes, driver fatigue, and time-wastage. Safety Step Company. NEB 15.

▲ ▲

Product marking is done for the purpose of identifying the markings an hour, a month or a year from the time marked. Paint will give this type of service, and is available in a stick form for handling ease. Samples of these paint marking sticks are available. Markal Company. NEB 16.

▲ ▲

Washfountains are available that employ a foot-operated sprayhead mounted at the back of a self-flushing deep bowl which prevents collection of dirty water. The bowl is made of stainless steel or white-enameled iron. Bradley Washfountain Company. NEB 17.

▲ ▲

A hot air burner for use with natural gas, coke oven gas, oil, tar or mixed gas, with combustion air at 600 F to 1500 F provides a highly efficient luminous flame. Can be used in soaking pits, billet heating furnaces, melting furnaces and other high temperature service. Bloom Engineering Company. NEB 18.

▲ ▲

Gravity batch filter for filtering and sterilizing lubricating, cutting, quenching, hydraulic and other oils. Dermatitis and other skin infections caused by contaminating oils are effectively checked by the sterilizing feature. Capacities 30 to 480 gal per hr. Bowser, Inc. NEB 19.

piston poppet assembly. No need to remove piping or remove valve from position. This model is already in production and available in 3-way (normally open or normally closed), 4-way, and 4-way (5 port) and in ¼ in., ⅜ in., ½ in. and ¾ in. sizes.

—E-29—

SCULLIN STEEL INSTALLS NEW STOPPER ROD OVEN

▲ The uncertainties of thorough drying of stopper rods and the difficulties of handling the drying of stopper rods have been completely eliminated by the Scullin Steel Company, St. Louis, Missouri, through the installation of a new type of recirculating convection oven.

Formerly the stopper rods were dried by means of blow torches or small wood fires. The drying was bound to be spotty and the stopper rods were not always ready when required. Oftentimes due to improper drying there would be splattering of metal which caused a hazard to the safety of the workmen.

With the new Despatch Oven Company's stopper rod drying oven, stopper rods are loaded individually on trolleys in a vertical position. These trolleys, through a switch arrangement, load the stopper rods in the oven on three tracks which run the length of the oven. Figure 1 shows the interior of the oven with the stopper rods in position. At the unloading end of the oven there are three doors — one for each line of track. This permits the oven door to be opened; a stopper rod removed and all this done quickly with a minimum loss of heat in the oven.

Note how the track system is arranged in Figure 2. As the stopper rods are removed from the oven, the trolleys return on a track alongside of the oven to doors at the loading end of the oven which are similar to doors at the unloading end.

The stopper rods are pushed through the oven manually and generally after one stopper rod is removed from the oven, another is put in at the other end of the oven to replace it. With this arrangement the stopper rods are always available when required and are always the right temperature and thoroughly dried.

It is reported that with the high speed convection recirculating system employed in this oven that the stopper rods are dried out much more quickly than they were formerly and that every rod is thoroughly processed. The hazard to the men from improperly dried stopped rods has been entirely eliminated.

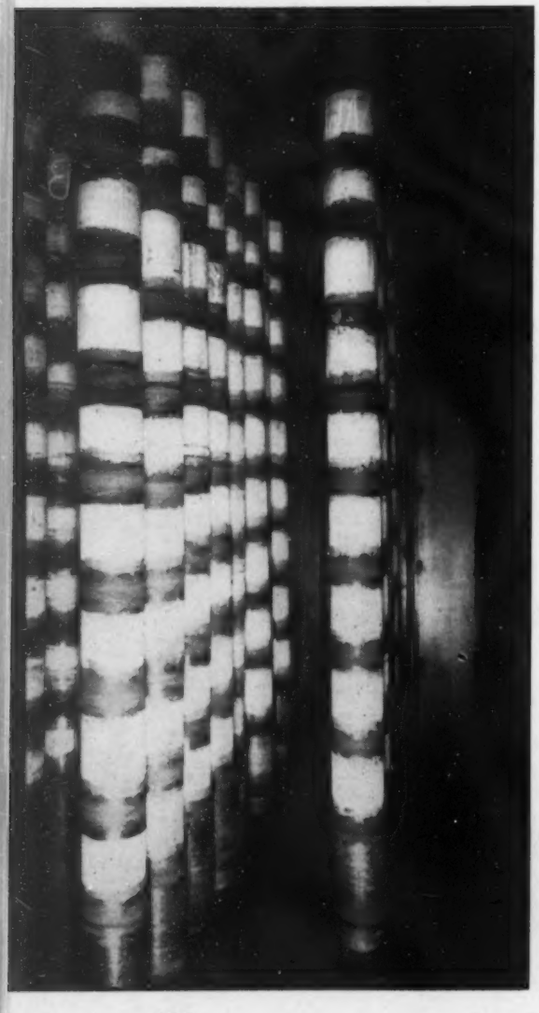
The oven has interior working dimensions of 6 ft wide × 20 ft long × 10 ft 6 in. high. This oven has capacity for 69 rods at one time and with approximately 20 or so rods being used each day, each stopper rod oven has a drying time of 2 or more days at an average operating temperature of 350 F. They may be dried much more rapidly than this if more rods are required.

250,000 Btu of heat per hour is the capacity of the direct fired externally mounted heater (Model DG250) which is provided for the oven and which will produce a maximum oven temperature of 425 F if required. The temperature control of the oven is entirely automatic and safety controls meet fire underwriters requirements.

Heated air is introduced into oven through special duct work at the bottom of the work chamber with recirculating duct at top. Separate vent removes moisture laden air to outside.

—E-30—

Figure 1 — Shown are the stopper rods in position in the interior of the oven.



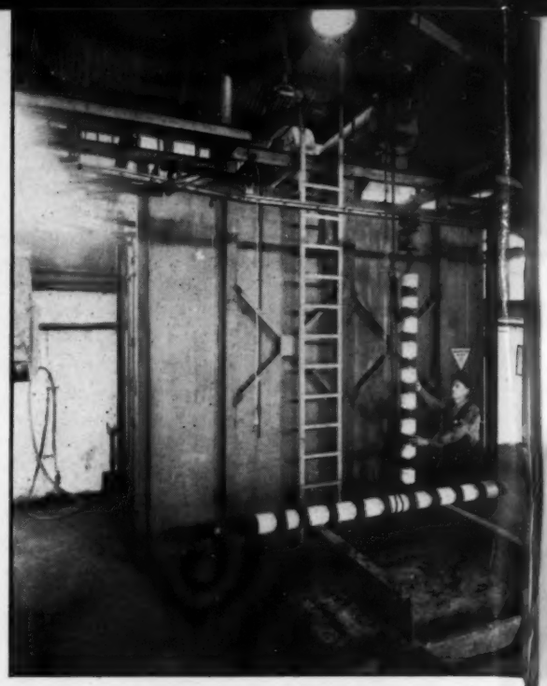


Figure 2 — As the stopper rods are removed from the oven, the trolleys return on a track alongside of the oven to doors at the loading end of the oven similar to doors at the unloading end.

BUILD 5 FURNACES FOR CONTINUOUS ANNEALING

▲ Contract for five continuous pipe annealing furnaces for United States Pipe and Foundry Company, and two licensees, Pacific States Cast Iron and Pipe Company and McWane Cast Iron Pipe Company, has been awarded to Rust Furnace Company.

Rust will construct the furnaces according to U. S. Pipe and Foundry design. Three of the furnaces will go to U. S. Pipe plants at Burlington, New Jersey; Bessemer, Alabama; and Birmingham, Alabama. One will be installed for Pacific States Cast Iron and Pipe at Provo, Utah; and one to McWane Cast Iron Pipe at Birmingham, Alabama.

The furnaces each have a capacity of 20 to 25 tons per hour. Those for U. S. Pipe and Foundry at Burlington and Bessemer have a range from three in. to 36 in. diameter pipe, while the remainder take a maximum 24 in. diameter pipe.

The furnaces are under complete

automatic temperature and draft control. Pipe is rolled through them on skids by a chain and finger conveyor. They are designed to utilize either by-product coke oven gas or oil for fuel.

In operation, the pipe enters the furnaces which are brought up to 1725 F, as rapidly as possible, and held at that temperature for 10 minutes. During the remainder of the time it undergoes a soaking cycle at approximately 1700 F. The pipe enters the cooling zone, where temperature drops rapidly to 1400 F, and then is gradually cooled to 1200 F, and discharged.

—E-31—

POWER TRUCKS FOR THE HANDLING OF HOT METAL

▲ Power trucks are being used more extensively in heat-treating operations mainly because of their ability to handle large loads of metals, hot or cold, with speed and safety. Recently some practical types of "home-made" equipment for work with them have been noted. By "home-made" is meant devised in plants to solve their own problems, suggesting similar applications elsewhere.

A company manufacturing iron and steel valves installed a battery of four heat-treating furnaces. It had difficulty in synchronizing their work with machining and assembling operations when all materials were transported by means of hand trucks. This department has capacity for finishing 40 to 50 tons of commercial iron and steel castings and accessories and assembling them into complete valves, daily. A substantial portion of the shells and other parts are heat treated. Two Elwell-Parker Electric Company low-lift platform trucks now do all the materials handling in this department, and also provide for a continuous flow of parts to and from the heat-treating equipment.

Parts to be heat treated are moved to the furnaces in skid boxes. When heated to the right temperature they are quenched in oil by being raked directly into tanks placed close to the furnace door on the platform of a truck. The company has constructed four of these tanks as shown in the illustration at the left. Cross bars are welded into the underframes at the height of the truck's platform. These strengthen the framework and provide means for lifting the tank and contents, weighing more than a ton.

After castings are quenched the load is picked up by the truck and moved to an open area for cooling, and another tank with oil is brought into place. Tanks are provided with hinged covers which are closed while they are being transported.

Another company that manufactures bearings and bushings consumes a large tonnage of strip steel in addition to bronze and other metals.

A considerable number of the coils are unwound, the steel passed through a copper-lead composition and rewound. Coils are piled on skids in loads of 12,000 to 15,000 pounds and are transported on power trucks to annealing ovens. The skid remain with the strip steel in the ovens which are heated to a temperature of 425 F.

The ordinary type of skid buckled, so the company devised a skid consisting of two lengths of channel steel forming runners. Along the top ledge of each runner is welded a

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corresponding length of square steel tubing. Tubing of similar size is used to connect by welding the runners at six points. This assembly provides the necessary strength and rigidity. The top which forms the platform for the coils is virtually an open framework, air space retarding heat absorption. A similar difficulty has been overcome by some manufacturers of forgings by using skid boxes provided with double bottoms. Boxes also have been built with short lengths of discarded boiler tubes placed side by side to form a heat-dispersing bottom.

—E-32—

DEWPOINT RECORDER FOR GAS HUMIDITY

▲ A new dewpoint recorder which can determine automatically and continuously the amount of moisture in a gas has been announced by the General Electric Company. The new instrument is designed for applications where the moisture content of atmospheres and gases must be measured or controlled, such as in checking furnace atmospheres, testing city gas, or determining the humidity of gases used in factory production processes.

The new dewpoint recorder is a combination of heater, refrigerator, mirror and gas chamber. The test gas enters the gas chamber and comes in contact with a metal mirror. The refrigerator and heater cool or heat the mirror until a temperature is attained at which moisture in the gas forms dew on the mirror.

A photoelectric eye watches the mirror, and the mirror temperature is recorded on a graph or chart the moment dew forms. Working in coordination, the refrigerator and heater hold this dewpoint temperature within a tolerance of two degrees so that a continuous reading on the chart is achieved. The dewpoint temperature that is recorded can then be converted into the moisture content of the gas if desired. The recorder can be arranged so that it will flash or sound a warning when moisture in the gas reaches too high or too low a level, or control other equipment which will dehumidify or add moisture to the gas.

The new instrument is designed for operation at atmospheric pressure over a dewpoint range from ambient to –90 F. After initial installation, only minor adjustments are required for continuous operation.

The dewpoint recorder is a combination of heater, refrigerator, mirror and gas chamber.

—E-33—

SCIENCE TO STUDY CORROSION OF METALS

▲ Corrosion of metals, cause of one of the world's greatest economic losses, will be studied in a coordinated program of instruction and research at the Massachusetts Institute of Technology, it was announced today with the appointment of Dr. Herbert H. Uhlig as an associate professor in the department of metallurgy to take active charge of the project.

In order to consolidate the attack on this major problem, which it has been estimated, causes losses amounting to several billion dollars annually, Dr. Uhlig will cooperate closely with all departments of the Institute concerned with corrosion. The subject has been under investigation at MIT for many years and important work has been done by the departments of metallurgy, chemical engineering, and chemistry. Organization of the corrosion program as a project on which the resources of all departments will be brought to bear is expected to expedite the search for methods of preventing or controlling corrosion. In the oil industry alone it is conservatively estimated that losses from corrosion amount to approximately $125,000,000 a year in refineries and $50,000,000 in pipe lines.

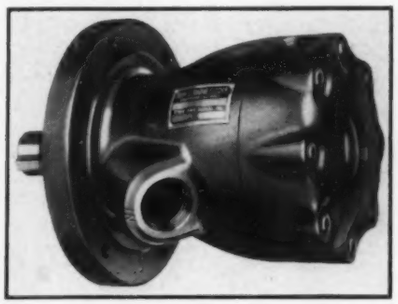
Studies of corrosion began at MIT with the notable work of Dr. Willis Whitney and Dr. William H. Walker in the early years of the present century. This was followed by important contributions by Professor Walter H. Whitman, head of the department of chemical engineering, and his associates, in the early 1920's. In the years that have followed, corrosion has been studied almost continuously. Dr. Uhlig graduated from Brown University in 1929 and completed his work for the doctorate at MIT in 1932. After a year as physical chemist at the Rockefeller Institute he went to Lever Brothers as research chemist and became assistant chief chemist in 1937. He then joined the MIT research staff to take charge of a project dealing with the corrosion of stainless steel. Later he was called to the Research Laboratory of the General Electric Company where he has been engaged in research on corrosion and allied problems. Dr. Uhlig has published a number of papers on corrosion and is editor-in-chief of "The Corrosion Handbook" to be published shortly.

Dr. Uhlig, who joins the Institute's staff on July 1, is planning a fundamental research program with the study of the nature of metals and metal surfaces as its main objective. The problem will be attacked largely from the electrochemical viewpoint and is expected to lead to a more logical approach to the selection of corrosion resistant metals and to methods of protection.

NEW HYDRAULIC PUMP FOR CIRCUIT SIMPLIFICATION

▲ The John S. Barnes Corporation has announced another important addition to its rapidly expanding line of hydraulic structures and units. The new addition will be known as the "Barnes Equalized Roto-Blade Pump."

Outstanding features of the pump are quiet operation, extremely high efficiency, long life, minimum maintenance costs, and working pressures to 1000 psi continuous or 1500 psi intermittent. This combination of features effects a major saving in initial cost through the simplification of circuit design and greater compactness in space required for a given speed and power.



In this pump bearing loads are neutralized by equalized and diametrally opposed radial hydraulic thrust loads.

The new pump is available in many combinations. It can be had as a single pump, double pump, single pump with feed pump, double pump with feed pump, and a single pump with gear pump. Capacities of pump range from 8.5 gpm to 50 gpm. Thus the pump offers a degree of versatility that fits it for practically any type of application desired.

Two important factors are responsible for the long life and high efficiency of the pump. One is that bearing loads are neutralized by equalized and diametrally opposed radial hydraulic thrust loads. To all intents and purposes this means that bearing loads due to pressure have been virtually eliminated. The second factor is that the impeller assembly, which includes the bushing and all moving parts, may be readily removed and a new impeller assembly inserted if long service makes such a step desirable.

—E-35—

ELECTRIC TRUCK USE HAS GIGANTIC INCREASE

▲ A 350 per cent increase during the past 21 years in the number of battery-powered industrial trucks in use in American industry is revealed in a survey, results of which are announced today by the Electric Industrial Truck Association.

The survey for all industry in the United States shows 39,782 such trucks in use at the end of 1944 as compared with 11,350 in 1923. The figures cover all makes of trucks, and are not limited to the products of members of the association who manufacture approximately 90 per cent of such equipment produced in this country.

The survey reveals that use of electric trucks in material handling systems in American industry showed consistent growth of some 65 per cent in the period from 1923 to 1931, held steady during the depression years, then more than doubled in the years from 1931 to 1944, although during the war years production was not permitted to rise to levels consistent with the demand for such equipment because motors and other parts were essential to so many other items in the war program.

—E-36—

POWER EXHIBIT SHOWS MODERN PLANT OPERATION

▲An investment of 239 million dollars in applying seven modern electrical techniques to manufacturing would help American industry to overcome rising costs in materials and labor by producing faster, better and more economically, leading utility executives and engineers of the nation were told recently in New York.

Addressing the Edison Electric Institute's conference at the Waldorf-Astoria Hotel, C. B. Stainback, manager of the Westinghouse Electric Corporation's Industrial Department, listed seven techniques in introducing a "Productive Power" exhibit which is soon to tour the nation to help industry solve many of its production problems.

INTENSIVE COURSE IN ELECTRICAL MEASURING

▲ Designed to give in a clear, concise manner a fundamental knowledge of the construction, operation and selection of electrical measuring instruments, an intensive course including sound slide films, a complete pocket size textbook, and an instructor's manual, has been prepared by the Westinghouse Electric Corporation.

Primarily for use by the Westinghouse organization, the course has also been made available to educational institutions, engineering societies, and the engineering departments of all organizations that use electrical measuring instruments. Cost of a complete course, based on a class of twenty members is $45.

Subjects covered in films and lessons are:

Film 1 — Importance of Electrical Instruments.

Film 2 — The Permanent Magnet Moving Coil Mechanism.

Film 3 — The Electro-Dynamometer Mechanism.

Film 4 — The Stationary Coil and Moving Iron Mechanism.

Film 5 — The Rotating Vane Mechanism.

Film 6 — The Selection and Use of Electrical Instruments.

It is recommended that the course be given in six one-hour sessions, with each session covering one lesson. An instructor's manual, giving suggested classroom procedures and containing essential reference material, is provided.

—E-37—

Book Review

▲ Of particular interest and value to the younger metallurgists and to all heat treaters, as well as to production engineers and designers, is the simple, straight-forward discussion of the fundamentals of heat treatment just prepared by the Research and Technology Department, Carnegie-Illinois Steel Corporation, United States Steel Corporation subsidiary. This 2-color, 8½ × 11 in. wire bound 54-page booklet, effectively illustrated with clearly explained charts, diagrams and photographs, devotes 26 pages to factors concerning hardness, covering heating, pearlite, bainite, martensite, S-curve, hardenability, and quenching. The next 26 pages relate to toughness, covering such factors as tempering, shape of piece, notch-bar, austempering, stresses, and cracking. Six concise fundamental statements summarize the detailed explanations, and a valuable table of Jominy end quench distances vs. bar diameters for six different quenching conditions concludes this new booklet. Copies may be secured from any office of American Steel and Wire Company, Carnegie-Illinois Steel Corporation, Columbia Steel Company, National Tube Company, or Tennessee Coal, Iron and Railroad Company.

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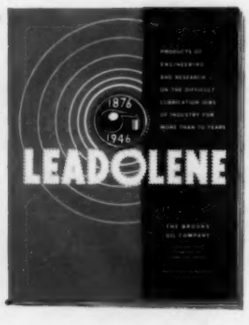

The Brooks Oil Co.

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Cleveland, Ohio
Hamilton, Ontario

Warehouses: In Principal Industrial Cities

Personnel News . . . .

C. J. Duby has been appointed general superintendent of flat rolled products, for the Warren district of Republic Steel Corporation. Until this appointment, Mr. Duby has been chief engineer of Republic Steel Corporation, Warren, Ohio.

From 1907 to 1912, Mr. Duby served as assistant to field engineer with the Eastern Steel Company at Pottsville, Pennsylvania. In 1912 he became field engineer and held this post until 1917 when he became mechanical engineer for the Republic Iron and Steel Company at Youngstown, Ohio. He was appointed manager of the Federal Iron Works Company at Youngstown in 1922 and in 1923 was appointed manager of the Steel City Iron Company at Youngstown. In 1927 he was employed as chief draftsman for the Trumbull Steel Company at Warren, Ohio, holding this position until he was appointed assistant chief engineer for the Republic Iron and Steel Company at Warren, Ohio, in 1929. In 1933 he became chief engineer for Republic Steel Corporation at Warren, which post he held until his recent appointment.

Mr. Duby, a registered professional engineer in the State of Ohio, is a member of the National Society of Professional Engineers, the Association of Iron and Steel Engineers, and the Warren and Youngstown Chambers of Commerce.

H. K. Ihrig succeeded Mr. Duby as chief engineer of the Warren district of Republic Steel Corporation. Mr. Ihrig started with the Dravo Contracting Company at Pittsburgh, Pennsylvania in 1914 as a draftsman. In 1920 he became an engineer for Heltzel Steel Form Iron Company, Warren, Ohio, holding this position until 1924. In the latter year he became a designer for the American Sheet and Tin Plate Company at Pittsburgh, Pennsylvania, and in 1926 he became assistant chief draftsman. In 1935 he was appointed chief draftsman. The American Sheet and Tin Plate Company had consolidated with Carnegie-Illinois Steel Corporation and in 1936 Mr. Ihrig became assistant chief engineer, construction engineering bureau, for that company at the Pittsburgh office. In 1939 he was appointed assistant chief engineer for Republic Steel Corporation at Warren, Ohio, and held that position until his recent advancement to the chief engineering post in the Republic's Warren district.

Mr. Ihrig is a member of the Association of Iron and Steel Engineers and the Warren Chamber of Commerce.

N. E. Rothenthaler was recently appointed as chief metallurgist of the steel mill for the Ford Motor Company, Detroit, Michigan.

A graduate of Massachusetts Institute of Technology, Mr. Rothenthaler has been associated with the Ford Motor Company for the past eleven years and, prior to that, for two years with the Great Lakes Steel Corporation.

During the wartime period he served as a member of the ferrous metallurgical advisory sub-committee for rolled armor plate, also with the committee on research and production of armor plate for all armored cars.

Walter P. Berg has been appointed general manager of the machinery division of the Dravo Corporation, Pittsburgh, Pennsylvania. Mr. Berg assumes the duties of **W. K. Fitch,** who recently became Dravo board chairman. Activities under Mr. Berg's supervision will include the sale and installation of heavy machinery, Dravo heating, power plant construction, Dravo-Doyle Company and sales distribution for such firms as DeLaval Steam Turbine Company, Cochrane Corporation, The Allen-Sherman-Hoff Company, C. H. Wheeler Manufacturing Company, Carrier Corporation, Iron Fireman Manufacturing Company, Tri-Lok Steel Grating Company and other machinery manufacturers.

Mr. Berg graduated from Lehigh University (M.E. degree) in 1917 and came with Dravo Corporation as an

C. J. DUBY

N. E. ROTHENTHALER

W. P. BERG

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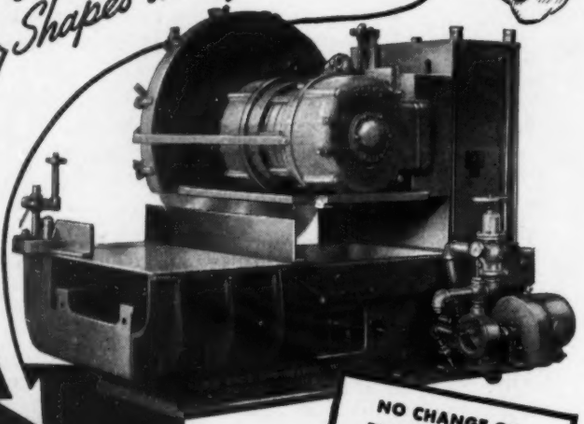

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assistant engineer in 1923. Until 1938, he was active in engineering and sales work with the machinery division of the corporation and since that time he had been in charge of the power department of Dravo Corporation's machinery division.

RALPH J. KNERR

Ralph J. Knerr was appointed assistant division superintendent of the alloy and tool steel division, Bethlehem plant, Bethlehem Steel Company, as announced by **J. M. Sylvester,** general manager. The appointment was effective June 1. Mr. Knerr has been superintendent of the Lehigh mills since April 7, 1939.

Mr. Knerr was graduated from Lehigh University in 1920 with the degree of bachelor of science in mechanical engineering. Following graduation he entered the employ of Bethlehem Steel Company and, after a brief period, became a test helper, in which capacity he served until March 1921, when he was made a moulder helper in the steel foundry. In October of the same year he was transferred to the combustion department, advancing through the positions of experimental engineer helper and experimental engineer to his appointment in June 1929, as assistant combustion engineer.

In January 1934, Mr. Knerr was made general foreman of maintenance, alloy and tool steel division, continuing in this capacity until he became superintendent of Lehigh mills in 1939.

Mr. Knerr is a member of the Association of Iron and Steel Engineers and of the Engineers Club of the Lehigh Valley.

Elmer A. Schwartz, 45-year-old veteran steel operating man, has been named president of Portsmouth Steel Corporation. Mr. Schwartz comes to his new post from the Republic Steel Corporation, of whose Youngstown district he has been assistant manager since 1943.

Mr. Schwartz will assume complete charge of operations for Portsmouth Steel Corporation, which is acquiring the present Portsmouth, Ohio, works of the Wheeling Steel Corporation. Part of Portsmouth Steel's output will be supplied to Kaiser-Frazer Corporation and Graham-Paige Motors Corporation for the production of Kaiser and Frazer cars.

Born in Pittsburgh, Mr. Schwartz has been continuously associated with the steel industry for twenty-seven years. His first experience was in the cold-rolling

and cold-drawing departments of the Jones and Laughlin Steel Corporation from 1919 to 1923. Mr. Schwartz joined the mechanical department of the Youngstown Sheet and Tube Company in 1923 and, after completing an apprenticeship of experience in all of the company's operating departments, specialized in open-hearth work. He was superintendent of open hearths at Youngstown's Brier Hill works in 1940, when he left to become chairman of the Open-Hearth Committee of Republic Steel in Cleveland. He is an active member of the American Iron and Steel Institute and the American Institute of Mining and Metallurgical Engineers. At present, he is chairman of the Iron and Steel Institute's technical committee on open-hearth steel-making and executive committee member of the AIME's open-hearth committee.

Mr. Schwartz will make his headquarters at Portsmouth, Ohio, where the works cover approximately 190 acres of land, and include a by-product coke plant with an annual capacity of approximately 450,000 tons, a blast furnace with a capacity of about 285,000 tons, 10 open-hearth furnaces with a rated capacity of approximately 612,000 tons, mill equipment for producing semi-finished steel, a rod mill with a 192,000-ton capacity, a wire mill and a number of other units including iron, steel and brass foundries.

W. Frank Kelly has been appointed general superintendent of foundries of the American Manganese Steel Division of American Brake Shoe Company with his headquarters in Chicago Heights, Illinois. Mr. Kelly

W. FRANK KELLY

who was formerly works manager of the Amsco plant in New Castle, Delaware, has been associated with the division in various capacities since 1925. A native of High Bridge, New Jersey, he has resided in New Castle, Delaware for more than 20 years.

J. M. Fenner has been appointed division superintendent, stainless steel, at the Waukegan, Illinois, works of the American Steel and Wire Company, United States Steel subsidiary. **Ronald E. Griffiths** will succeed him as supervisor of the research laboratory in Cleveland, Ohio.

Mr. Fenner is a native Clevelander and has lived

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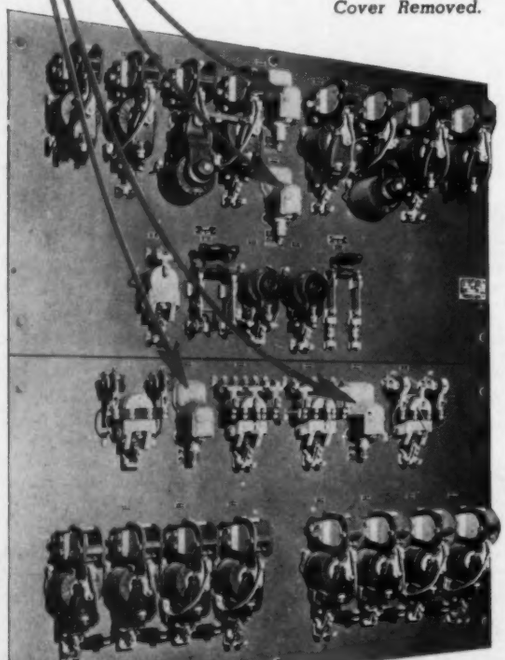

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However, under sustained overload, this plunger has a tendency to rise to the coil center, thus permitting a gradual increase in flux. The upward movement of the plunger is retarded (proportional to the value of the overload) and at a certain point, the flux density has increased to a value sufficient to operate the Relay.

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(1) Bearing Reference Books

Two catalogs on solid roller bearings of the radial type are available. Data is included on bearing type selection; dimension and load rating tables; bearing size selection; designing the bearing installation; bearing lubrication. With this book is a supplemental book with size sheets and data on all bores. (546, 92 pages; Supplemental, 76 pages). Hyatt Bearings Division, General Motors Corporation.

(2) Rolling Mill Equipment

A catalog is available describing full-hydraulic, self-contained, semi-automatic and electrically controlled rolling mills, pumps, accumulators, and hydraulic presses. Diagrams and cutaway photographs with complete engineering data are included. Hydropress, Inc.

(3) Arc-Welding Electrodes

"Hard Surfacing with Hardex Arc-Welding Electrodes" is a new bulletin giving properties of this material and demonstrating how deposits are affected by temperature, chemical composition, and rate of cooling. Electrode selection, case studies of users, and application procedure are included. (16 pages). Metal and Thermit Corporation.

(4) Compressor Units

A new bulletin is available describing a gas-engine driven compressor unit. The bulletin details the advantages of horizontal compressor cylinders with V-angle power cylinders in the same vertical plane, offering compactness and space economy to as much as one-third the amount required for vertical compressor units of equal horsepower. The bulletin includes a cross-section diagram showing component location, illustrations of parts, and complete specifications. (338) Cooper Bessemer Corporation.

(5) Mechanical Pickler

"The New Weldco Mechanical Pickler" is the title of a booklet that is available to you. The booklet tells how the pickling of steel bars can be greatly accelerated by the practice of raising and lowering a sling full of bars in the pickle vat. Complete details of how pickling time can be cut 40 to 60 per cent are included. Youngstown Welding and Engineering Company.

(6) Mill Data Book

A revised and enlarged pocket-size edition of "Useful Information" has just been published. The book includes data on cupola melting and linings; electric furnace data; electrode data; melting and annealing methods; melting points of metals and alloys; range of crane speeds; data on electric lifting magnets; ladle capacities in iron and in steel; ladle selection; weights of various materials; pressure and metric equivalents; and other useful tables of a similar nature. (FY140). Whiting Corporation.

(7) Lubricated Plug Valves

An illustrated bulletin on full pipe area lubricated plug valves is available. The bulletin tells the "Why" and "When" in the use of gate or globe valves and lubricated plug valves. Contains illustrations and technical data on full area straightway semi-steel valves, round port full area semi-steel valves, multi-port full area semi-steel valves and reduced area valves. American Car and Foundry Company.

(8) Industrial Trucks

An excellently prepared book on electric industrial trucks is now available. The book contains sectionalized pictures of the trucks showing the operating parts and describing each in detail. Included are general specifications on drive units, hoisting and tilting power units, driving motor, driving controller, brake, wheels and batteries. Installation and application views with descriptions of the types of operations are included. (P442, 36 pages). Yale and Towne Manufacturing Company.

(9) Electrical Products

The major products of an electrical manufacturing company are included in a new catalog. The products included are transformers, reacters, fuses, fustats, plug fuses, ballasts, and solenoids. Included are technical data, illustrations, and diagrams on all of the foregoing products. Renewable and non-renewable fuses are described. (451-GB). Jefferson Electric Company.

(10) Crane Controllers

A bulletin on a new line of controllers for operating a-c cranes from the floor level is available to you. Illustrated in this bulletin is the operation from a pendant push button station or from rope-operated master switches. The controllers, for mounting on the trolley or along the crane girders are of the magnetic contactor type. (931). Electric Controller and Manufacturing Company.

(11) Crane Cab Coolers

A folder is available describing air rectifiers with air-cooled condensers for low maintenance. The folder describes these efficient units which do a year round air-conditioning job. The units protect operator health, provide 85 F crane cab temperature, remove noxious gases, smoke, fumes, and oil vapors. (AC42246). Lintern Corporation.

(12) Pumps, Turbines, and Softeners

A bulletin is available discussing a complete line of steam turbines, surface condensers, circulating pumps, steam-jet ejectors, condensate pumps, relief valves, hydraulic tube washers, water softeners, pressure filters, deaerators and deaerating heaters, boilerfeed pumps, heater drain pumps, air compressors, centrifugal pumps, and meters. (WP-1099-B13). Worthington Pump and Machinery Corporation.

(13) Steam Generator

Just issued is a revised and enlarged catalog featuring steam generators which are built for capacities from 15,000 to 300,000 lb of steam per hr and for pressures to to 1000 psi and steam temperatures up to 910 F, with various methods of firing. Included are design and construction details which are fully illustrated. (VU). Combustion Engineering Company.

(14) Swivel Joints

A new catalog describes over 500 different types, styles and sizes of ball-bearing swivel joints for use wherever movement or rotation is required in pipe lines handling liquids, vapors and gases. A formula for perfect flexibility is included which may be the answer to your problem. Chiksan Company.

(15) Bearing Achievements

"Bearings and their peerless achievements" is the title of a brochure that is available to you. The book reports improvements attainable through use of molded fabric bearings. Operational use of bearings are shown in equipment in every conceivable phase of industry. (64 pages) Gatke Corporation.

(16) Purifying Oil

"How to Completely Clean Dehydrate Degasify and Stabilize oils for Transformers, Circuit Breakers, Oil Filled Cable, Turbines, Vacuum Pumps, and Steel-Mill Bearings" is the title of a completely prepared book. Included are case histories in detail with complete descriptions of processes used in each of the foregoing types of steel mill equipment. (100). Buckeye Laboratories Corporation.

(17) Recording Counters

A folder is available giving application data on electric counters. The folder describes how the counters operate by the opening and closing of an electric circuit each cycle registering one count up to 99,999. Power requirements are only two watts. The counters are built for panel mounting and are used for recording operations of circuit breakers, switches, elevators, pumps, scales, and production machines where a count is desired. (MA). Royal Electric Manufacturing Company.

(18) Rotary Blowers

Just issued is a bulletin covering rotary positive blowers. The new bulletin covers the many applications for which this type of blower has been found useful and efficient over a long period of years. Described are the wide range of sizes from 5 to 50,000 cfm, at pressures up to 30 lb, and for vacuums up to 28 in. mercury. Included are numerous installation illustrations, characteristic curves, cross-sections, and exploded views to show the operating principle and construction features. (22; 23-B-12). Roots-Connersville Blower Corporation.

(19) Welding Magazine

A monthly magazine on welding is available to which will keep coming as long as you care to receive it. The magazine describes various welding problems and the solutions to these problems. (Euctectic Welder). Eutectic Welding Alloys Corporation.

(20) Soaking Pits

A blueprint and descriptive booklet is available to you on the biggest improvement yet in soaking pits. This improvement is a new patented pit which was developed after a close study of the merits of all other types of soaking pits. It is the finest that the most complete engineering information regarding all pits built in the past could make possible. The booklet describes the heat distribution; increased charging capacity per sq ft of pit area; and all operational hazards are eliminated. Wellman Engineering Company.

(21) D-C Mill Control

Looseleaf file sections are available describing heavy duty d-c mill control. The first section: "Mill Auxiliary Control," contains detailed description and data on all controls for steel mill auxiliaries. The second section: "Master Switches — Push

Buttons, Limit Switches" completely covers all types of switches for steel mill operation. All steel mill engineers and operators interested in electrical control should have this file for ready reference. Square D Company.

(22) Buyers' Guide

A buyers' guide on pyrometer supplies has been prepared for you. The book is complete in its information to instrument men and purchasing agents on how to order thermocouples, protecting tubes, thermocouple wire, lead wire, insulators, etc. The book contains complete descriptions and prices on various types of standard thermocouples for application in all industries. (100-1). Brown Instrument Company.

(23) Tank Rheostats

Cast grid type tank rheostats for electroplating control are described in a folder which is available to you. The booklet gives the features of the rheostat which includes the amperage, voltage, tapered type rheostat, current regulation, overload capacity, short circuiting switch, and the instruments. Also included in the folder are the construction features. (TR-10546). Columbia Electric Manufacturing Company.

(24) Mobile Crane

A mobile swing boom crane is described in a new catalog. The crane, named "Krane-Kar", can be used inside of plants and outdoors, and as the catalog points out it can be used for a general all-around utility crane. The operator has easy access to the controls for hoisting, for swinging and topping the boom and also the controls for traveling forward and reverse. It can be used for storing and stacking materials, for lifting and transporting, and for general maintenance work. (58). Silent Hoist and Crane Company.

(25) Furnace Construction

A new catalog "Refractory Specialties" is available for distribution. It contains numerous cross-sectional drawings, charts, graphs, technical illustrations and descriptions of refractory specialties. Included are industrial furnace applications and construction designs covering annealing, billet and plate heating, coke ovens, normalizing, pit covers and ladle covers, stress relieving, and many other types of furnaces. The Ramtite Company.

(26) Cranes and Hoists

Overhead traveling cranes and hoists are described in a new bulletin which is available to you. The bulletin describes cranes for every type of material handling. Standard single hook or double hook cranes for handling steel, castings, machinery; magnet cranes for yard service; and bucket cranes for bulk materials. (S-712). Northern Engineering Works.

(27) Chemical Cleaner

A pamphlet is available to you on the use of a new acid-type chemical cleaner for metals. It suggests methods for removing boiler scale, general pickling operations, cleaning of heat transfer equipment and stripping zinc plate. Described is the use in pickling and descaling operation. The cleaner is effective, fast, and economical. (PM90). Pennsylvania Salt Manufacturing Company.

(28) Purifying Equipment

A complete catalog on purifying equipment is available to you. The catalog contains specific specifications on standard purifying equipment, including: internal steam purifiers, line purifiers, receiver purifiers, evaporator purifiers, and other purifiers. The catalog is a collection of bulletins issued from time to time by this company. Centrifix Corporation.

(29) Expansion Joints

Ring controlled (packless) expansion joints for absorbing expansion, contraction and vibration in gas, air or liquid pipe lines are described in a well-arranged catalog which is yours for the asking. These joints are a necessity in providing for expansion in all lines of piping where a distinct variance in temperature occurs and for vibration where any axial movement is prevalent. Badger Fire Extinguisher Company.

(30) Forging Compound

"Leadolene" forging compound is covered in a bulletin available to you which is said to minimize stickers and eliminate build-up on dies. The bulletin tells how the new product deposits on the die an indestructible "ph-ilm" of micro thickness. The heavy flash and dense smoke, characteristic of most forging compounds, is reduced to a minimum. According to the bulletin the compound is pure and will not poison the pulmonary system, blood stream, or digestive tract of anyone coming in contact with it. Brooks Oil Company.

(31) Pneumatic Transmission

. . . . is the title of a data book covering transmitters operating on the force-balance principle, for the measurement and control of flow, pressure, liquid level, liquid density, and differential vapor pressure. (1000). Republic Flow Meters Corporation.

(32) Dust Control

A new catalog is available to you giving uses, construction, and sizes of exhaust fans which are particularly designed for dust control, fume exhaust, and collecting and conveying materials which can be carried on a current of air such as metal chips and dust from grinding operations. Performance tables which are given cover ratings for fans of from 25 to 60 in diameter with capacities from 680 to 20,000 cfm at pressures from 1 to 12 in. static pressure. (430-3) B. F. Sturtevant Company, Inc.

(33) Combustion Indicators

Bulletins are available to you on smoke and combustion indicators operated by an electric eye. These detectors are calibrated to read on a percentage from complete darkness to zero on a clear stack. The bulletins discuss design and operational features of these indicators, and are illustrated with sectional diagrams and photographic views. (381, 385, 431, and N-789). Ess Instrument Company.

(34) Speed Reducers

Your pocket-size edition of the speed reducer catalog awaits only the circling of the proper number below. This handy catalog includes a comprehensive engineering section as well as valuable data on overhung loads, lubrication, torque versus horsepower, and on selecting your speed reducers. (145). Winfield H. Smith, Inc.

(35) Blast Equipment

Complete information on the new 60 by 96 in. "Wheelabrater Tumblast" is contained in a catalog just published. The bulletin describes in detail the largest

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machine of its kind ever built, having a capacity of 63 cubic feet which will clean 6,000 pounds of steel castings in 15 minutes. Included are installation photographs, construction features, overall dimension drawings and specifications. (264). American Foundry Equipment Company.

(36) Boiler Feed Water

The control of boiler feed water in a new generating station is described in a new bulletin available to you. The "Copes flowmatic" regulator is used in this new station, and the principles of its operation are included in the description of the power plant. (453). Northern Equipment Company.

(37) Shell: Soldier and Civilian

. . . . is the title of a handsome cloth-bound book that is available to you. The book is a worthwhile addition to your library at the plant or in your den. It tells the story that oil has played in the past, and the story of its use during the recent World War, and the industrial plans for the future. The book is illustrated in color and has most interesting content matter. Shell Union Oil Corporation and Associate Companies.

(38) Pneumatic Conveyors

Discussed in a new catalog are the advantages and principles of pneumatic conveyors, suction systems, boat unloaders, coal unloaders, chemical unloaders, pressure systems combustion suction and pressure systems, dust collectors, portable conveyors and electric panel boards. Illustrated with cross-sectional views installation pictures, and application photographs, the book will convey to you the meaning and use of conveyors. Brady Conveyors Corporation.

(39) Electrical Insulation

A publication on "Fiberglas" electrical insulation materials is available to you. This publication describes forms and applications of electrical insulation. Photographs, diagrams, and tables are included. Fiberglas yarns, cloths, tapes, braids and cords are used for magnet wire, lead wire, special wires and cables, varnished cloths and tapers, mica combinations, laminates, saturated sleevings, and special products. (EL44-7A). Owens-Corning Fiberglas Corporation.

(40) Input Controllers

A series of bulletins and application data sheets are yours for the asking, covering electronic balancer input controllers for accurate control of electric furnace temperatures. The bulletins cover the control of current input to electric heating elements in furnaces, ovens, platens. It tells how there is no equipment to scrap with the installation of these controllers. (T49, T47, T50, ADS 10 and 18). Automatic Temperature Control Company, Inc.

(41) Silicones

. . . . how they are made and what they can do, and test results of silicone as electrical insulation. These subjects are reprints of two articles which appeared in a recent issue of the WESTINGHOUSE ENGINEER. The articles include curves, test result data, illustrations, and a complete description of silicone. These tests were conducted under the cooperation of the engineering research departments of two large corporations and the Mellon Institute of Industrial Research. Dow-Corning Corporation.

(42) Warehouse Slitters

A new warehouse slitter is covered in a bulletin available to you. This new metal slitting unit has been especially designed for compactness, smooth operation, safety, and quick set-up. The housings, payoff, winder and motor drive are all mounted on a single welded steel base, reducing floor space to approximately 4 ft by 6 ft. (1773). Torrington Manufacturing Company.

(43) Fuel Economy

"FUELOMIZER" is the title of a bi-monthly publication which will come to you if you encircle number fifty below. This periodical covers all phases of economy in the use of fuel. Typical titles of the technical articles are: "The Electric Eye Does It Better;" "The Story of the Gravigage;" "Some Pertinent Facts Relative to the Use of Salt;" "The Hays Veriflow Meter for Measuring, Indicating, Totalizing;" and "Keep Your Boilers at Peak Efficiency." John D. Hiles Company.

(44) Water Treatment

Two bulletins on water treatment are available to you. One covers scale retardent for use in boilers, feedlines, heaters, etc. The second is the answers to 102 questions on various problems of boiler feedwater. (28S and 30). National Aluminate Company.

(45) Valve Data Book

A data book on regulating valves is available giving the dimensions, descriptions, and parts list, typical installations, and rated capacities. (1A, 52 pages). Atlas Valve Company.

(46) Turbine Pumps

A bulletin is available containing a 24 in. cross-sectional photograph of this company's oil lubricated turbine pump and the features of the unit are described in detail. Directions for the selection of turbine pump are given and a table of sizes and ratings helps in specifying the proper unit. (ABQ400.1). Fairbanks, Morse and Company.

(47) Roll Grinding

An excellent little book has been prepared on the subject of "Roll Grinding." The subject is covered completely including: selection of the wheel for roll grinding; factors affecting roll grinding results; grinding hot mill rolls; grinding cold mill rolls; and roll grinding wheel specifications for steel mills. Every rolling mill superintendent and engineers interested in rolling should have a copy of this book. Norton Company.

(48) Control Valve

A bulletin is available to you describing a new differential oil flow control valve which solves the problem of obtaining constant liquid fuel flow to regenerative furnaces, regardless of variations in pressure before or after the valve. The bulletin describes how development tests were made under actual steel mill conditions. The valve demonstrates that any oil burner operation can be improved by its use. Bloom Engineering Company.

(49) Industrial Insulations

The use of a single one-block insulation material reduces installation time and cost, according to a bulletin that is available. This insulation is for all temperatures up to 1700 F and is called "Mono-Block." The booklet describes this strong, yet light and easy to cut, material, and tells how it yields readily to rivet heads or other irregularities of surface. Baldwin-Hill Company.

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K. C. McCUTCHEON

J. M. LOBAUGH

GEORGE YOST, JR.

here all his life, having been educated in the Cleveland Heights public schools before entering Case School of Applied Science from which institution he was graduated with a B.S. degree in engineering. Mr. Fenner has worked for the American Steel and Wire Company since August 1933, when he started as a laboratory assistant at Newburgh works. He has held his present position since March 1940.

Born in Rochester, Pennsylvania, Mr. Griffiths attended Pennsylvania State College where he was awarded a B.S. degree in ceramic engineering and a master's degree in ferrous metallurgy. He started working for American Steel and Wire in June 1937, at the Cuyahoga works, Cleveland, in the metallurgical department. He held a number of positions before being made a research engineer in June, 1944.

K. C. McCutcheon, formerly general superintendent of American Rolling Mill Company's Ashland plant, has been appointed as assistant to the vice president in charge of operations; **J. M. Lobaugh** has been named as general superintendent of the Ashland division; and **George Yost, Jr.,** assistant to manager of that division.

Mr. McCutcheon's new responsibilities will include special assignments in connection with raw materials and the development of blast furnace ores. Since the Ashland division is one of the Company's largest users of ore and other raw materials, he will retain his office and home in Ashland.

He joined the Ashland organization in 1922, and was made open hearth superintendent in 1924, continuing in that capacity until 1930 when he was appointed assistant general superintendent. In June, 1939, he was appointed general superintendent of the Ashland division, the position he had held until the present advancement.

Succeeding Mr. McCutcheon as general superintendent, Mr. Lobaugh was originally employed at the Butler, Pennsylvania, division of Armco in 1926. He advanced through a number of operating positions and became industrial engineer of that division in 1934. In 1943 he was transferred to Ashland to become assistant to manager, which position he has occupied until the recent promotion.

John B. Mitchell was appointed works manager for the Phoenix Manufacturing Company, Catasauqua, Pennsylvania. Mr. Mitchell had been manager of forging division and iron foundry for the Columbia Machine Works from 1944 to 1946. Previous to 1944 he had been employed from 1927 as a sales engineer for the Pittsburgh Forgings Company, Coraopolis, Pennsylvania.

J. E. Tweedy has been appointed assistant to the president of the Phoenix Manufacturing Company, Catasauqua, Pennsylvania. Mr. Tweedy was works manager for the same company previous to his new assignment.

Thomas P. Riley has been appointed general superintendent of Carnegie-Illinois Steel Corporation's Johnstown-Lorain works at Johnstown, Pennsylvania, it has been announced by **William C. Oberg,** manager of operations, Pittsburgh district of this United States Steel subsidiary.

Mr. Riley began with United States Steel at American Sheet and Tin Plate Company's Dover works, Dover, Ohio, in 1908. He went to the company's Gary, Indiana, plant in 1911. He served in the U. S. Army on the Mexican border, in France with the 26th "Yankee" Division during World War I, was one of the founders of the American Legion and is a past commander of Gary Post

Mr. Riley returned to the Gary sheet mills after the war and in 1936 was named superintendent of industrial relations for the company's sheet and tin mills in the Chicago district. The next year, he assumed the same position at Carnegie-Illinois' Irvin works, where he had the distinction of being the first man on the payroll. In 1946, he became assistant to the manager of operations of the Pittsburgh district, holding that position until now.

Mr. Riley inherited his talent as a steelmaker. His grandfather was chairman of the British Iron Masters Association and his father was a roller at the Dover plant of American Sheet and Tin Plate.

James L. Fee has been appointed as manager of industrial relations for all of Bethlehem Pacific Coast Steel Corporation's operations, which include three steel plants, two fabricating works and four mill depots. Mr.

The IMO PUMP requires no gears, because the fluid pumped is propelled from suction to discharge by the action of three intermeshing rotors. That's all there is to it—no gears, valves, vanes or pistons!

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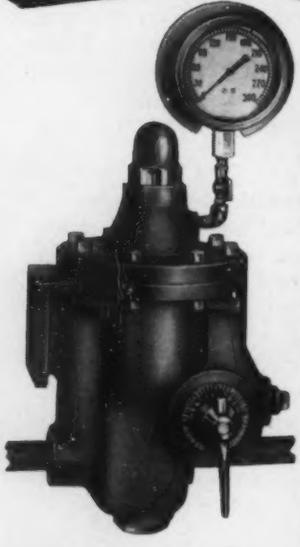

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Fee continues as assistant to **T. S. Clingan,** vice president in charge of mill operations. His new duties will include the direction of Bethlehem Pacific's industrial relations and pension and relief plans. He will maintain his headquarters at the South San Francisco plant.

Mr. Fee started in 1916 as a storekeeper in the South San Francisco plant of the Pacific Coast Steel Company, now owned by Bethlehem Pacific. In the years that followed, he advanced to chief of payroll, in which position he also handled cost distribution.

In 1930 when Bethlehem Steel Company took over the Pacific Coast Steel Company, Mr. Fee was made management's representative. In 1942, he was made assistant to T. S. Clingan, then general manager of steel operations.

Walter L. Longnecker has been made division superintendent of the rod mills in the Cuyahoga works, American Steel and Wire Company. He joined the company in 1939 and in June 1945 was made division metallurgist, rod mills, with offices in Cleveland.

Harry Wilson, Jr., formerly vice president in charge of operations, Jessop Steel Company, Washington, Pennsylvania, has been elected first vice president. He has been with Jessop for 40 years, other connections having been general superintendent and works manager.

Robert L. Moxley has been appointed vice president and works manager of the Southern Electric, Inc., of Hammond, Indiana. Mr. Moxley was formerly assistant to the general purchasing agent of Carnegie-Illinois

ROBERT L. MOXLEY

Steel Corporation at Pittsburgh, Pennsylvania. He is a graduate of the University of Wisconsin and had been with the Carnegie-Illinois Steel Corporation since 1930. Southern Electric, Inc., are manufacturers of electrical armatures and field coils.

Robert H. Owens has recently been elected vice president in charge of engineering and manufacturing of Roots-Connersville Blower Corporation, Connersville, Indiana, one of the Dresser Industries.

An engineering graduate of Purdue University, Mr. Owens has been active in engineering and research since 1912. He joined the engineering staff of Roots-Connersville in 1925, and since that time has been responsible

for many new centrifugal blower and compressor developments.

W. O. Lippman was elected a vice president of the Westinghouse Electric Corporation. Mr. Lippman will be responsible for all plant labor relations including national negotiations, relationship with all certified bargaining units and administration under labor contracts. He will report to **L. E. Osborne,** a senior operating vice president.

At the same time, it was announced that vice president **W. G. Marshall,** in addition to his administration of company-wide industrial relations, has been assigned increased responsibilities for community and public relations. Included are the formulation and administration of policy related to press relationships, community affairs, formation of general industrial relations policies, administration of employe benefit plans and services, technical employment, and the company's over-all health, safety and medical programs.

Mr. Lippman, a native of Harrisburg, Pennsylvania, began his career with Westinghouse as a motor winder in the main works at East Pittsburgh, Pennsylvania, during the summer vacation of 1917. After graduation from the Pennsylvania State College in 1918, he returned to the East Pittsburgh plant and within the next year was appointed foreman of test, in which capacity he served in three divisions until 1923. In that year he was transferred to the East Springfield works and appointed chief inspector of that plant.

From January 1935, to August 1936, Mr. Lippman was supervisor of industrial relations at the East Springfield plant. He then became, successively, superintendent of the motored appliances department and superintendent of the air conditioning department.

In May 1939, he was appointed works manager of the East Springfield plant and continued in that post until April 1943, when he was appointed manager of the war-born Canton, Ohio, ordnance division plant operated by Westinghouse for the Navy.

In December 1944, Mr. Lippman was appointed assistant to the president, with his office at company headquarters in Pittsburgh, and assigned responsibility for operations of the headquarters manufacturing division.

Mr. Marshall, a native of Pittsburgh, was graduated from Washington and Jefferson College in 1911, and from the University of Pittsburgh Law School in 1914. After a brief period with a Pittsburgh law firm, he went with the Pittsburgh Railways Company in March 1916, serving until February 1924, as chief of that concern's litigation bureau.

He then became manager of the adjustment department of the Philadelphia Company, and in September 1926, was named the company's director of personnel, a position he held until coming with Westinghouse in July 1929, as assistant to vice president. He was elected a vice president in October 1934, in charge of industrial relations.

Eight Bailey Engineers who have recently been released from military service, have rejoined the company and have resumed their activities in instrumentation, combustion, and automatic control engineering. These veterans have completed a refresher course at

(*Please turn to page 135*)

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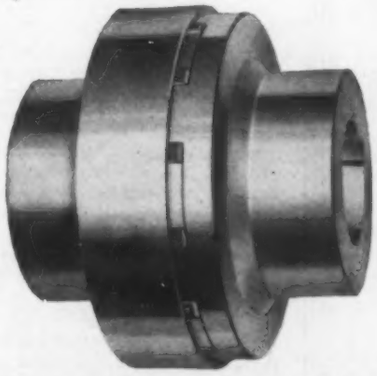

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DIXON'S GRAPHITE SLIPSTIK... This wax-like lubricating stick is used like a crayon for fast rub-on lubrication. Data Sheet #23 tells why it is indispensable for certain uses.

DIXON'S GRAPHITED OILS AND GREASES... Ready-to-use, fortified with Dixon's lubricating flake graphite, provide sustained lubrication for longer periods, especially under extremes of heat and pressure. Data Sheets #13 & 14 tell about Cup Grease and No. 677.

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Write Graphite Gus for any of above Data Sheets and Data Sheet Directory listing 11 other friction-fighting graphite products.

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FOR speedy operation, reliable service and over-all economy the Jones Skip Hoist Drive has made a name for itself in a wide variety of material handling service. These skip hoist drives are built as complete units by the Jones organization in several types with base to take any motor specified by the purchaser. They are equipped for all the modern protective devices such as cam or nut type limit switches, solenoid or disc type brakes and slack cable switches. The drives are single, double, or triple reduction Jones Herringbone Speed Reducers, built to stand up under the many years of pounding that a skip hoist drive has to take. The shafts are supported in roller bearings, with rolling action, rack generated gear and pinion teeth to insure easiest possible starting with low starting-peak loads. All reducer bearings and gears are automatic oil-bath lubricated.

The Jones organization has an extensive file of information on skip hoist drive problems and will be pleased to work with you on any problems involving such applications

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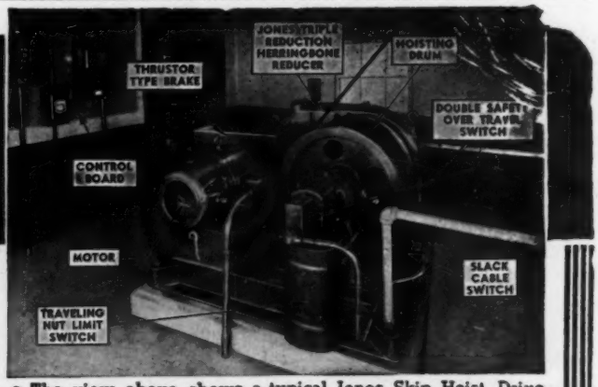
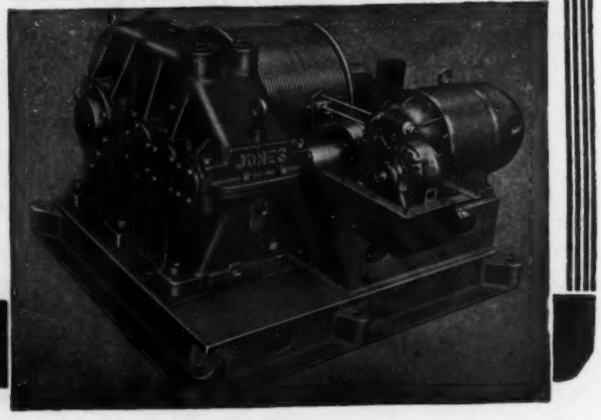


• The view above shows a typical Jones Skip Hoist Drive installation while the view below shows one of the Jones units equipped with traveling nut type limit switch, motor actuated brake, and slack cable switch.



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Bailey Meter factory in Cleveland, which brings them up to date on new equipment, procedures, and policies developed while they were away in service.

Most of these engineers are now located in the company's branch offices where they will assist power and process engineers in the application of suitable meters and controls for the improvement of operating efficiency and product quality.

The engineers released from the army have been assigned as follows:

J. A. Lucas to his former position in the Cincinnati office.

J. W. Herrington to his former position in the Atlanta office.

J. E. Zimmerman to the Detroit office.

A. L. Danielsen to the Denver district.

S. T. Novak to the position of quality engineer at the Cleveland factory.

Engineers released by the navy have received the following assignments:

H. R. Jamieson to the proposition department in Cleveland.

H. C. Schink to the Boston office.

Vincent Beno to development work in the company's Research department.

Two engineers from the Canadian Army have recently returned to the company's Canadian subsidiary, Bailey Meter Company Limited, and after taking the refresher course at Cleveland, resumed their activities in Canada. They are: **W. L. Thompson,** manager of the Toronto branch office, and **W. A. Nelson** of the Canadian head office at Montreal.

Clyde E. Cochran has retired as director of engineering of Elwell-Parker Electric Company, Cleveland, Ohio builder of power industrial trucks, and has been succeeded by **Dwight Hanchette,** associated with him at Elwell-Parker for many years.

A native of Twinsburg, Ohio, Mr. Cochran graduated from Case School of Applied Science, Cleveland, in 1902. He went to work for the company in that year and has been identified with it continuously for 44 years. He is one of the most prominent engineers in the industrial-truck field.

At the turn of the century Elwell-Parker was engaged principally in manufacturing large direct-current generators and motors for hoisting and conveying equipment. Mr. Cochran was instrumental in their design and construction, in collaboration with the last **M. S. Towson,** one of the founders of the present Elwell-Parker Company.

Obituary

Michael J. Ward, 63, foreman of the sheet galvanizing department of Youngstown Sheet and Tube Company since 1915 and widely known as an authority on galvanizing, died June 5, 1946.

Mr. Ward entered the galvanizing business in 1903 under his father, M. Joseph Ward, Sr., with the American Rolling Mill Company at Middletown, Ohio. He became foreman for Sheet and Tube after the death of his father, whom he succeeded.

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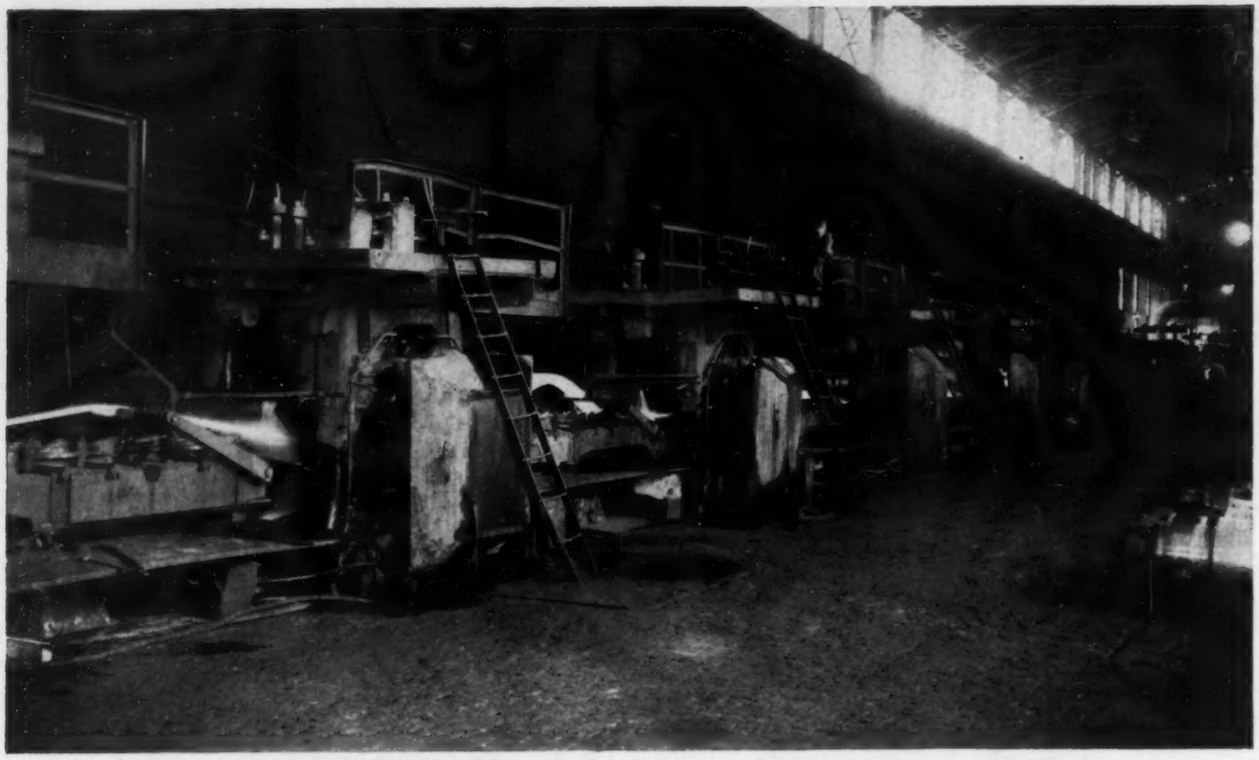

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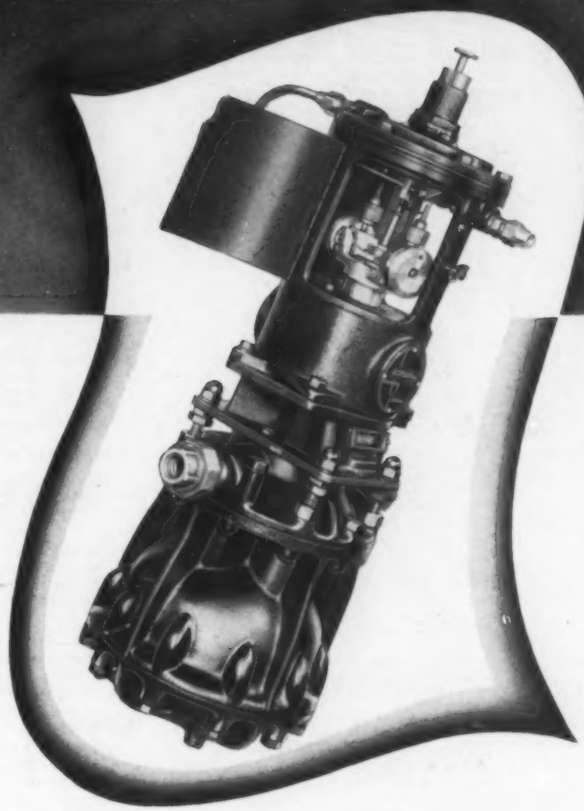

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TO BE HELD IN CLEVELAND PUBLIC AUDITORIUM, CLEVELAND, OHIO, OCTOBER 1, 2, 3, 4, 1946

LIST OF SUBJECTS TO BE PRESENTED

"Power Factor Control on Arc Furnaces"
"Discussion of Mill Type Motor Ratings"
"Gearing for Steel Mill Auxiliaries and Cranes"
"Relative Costs of A-c and D-c Transmission"
"Spot Conversion of Electrical Current"
"Latest Trends in Commutation"
"Electrical Equipment for the Sendzimir Mill"
"Schemes and Methods for the Control of Plugging"
"Material Handling in Steel Plants"
"Scheduling of Maintenance Shops"
"Automatic Welding in Steel Plant Maintenance"
"Developments in Submerged Heating"
"Heat Problems in the Steel Industry"
"Improved Design of Metallic Recuperators"
"Heating and Melting Furnace Controls"
"Relation of Refractory Economy to Combustion in Steel Mill Furnaces"
"Heating Rate Tests of Slab Reheating Furnaces"
"Economics of High Pressure Steam for Steel Plant Power"
"Recent Improvements in Cover Annealing"
"Chemical Removal of Scale, Sludges and Oxides from Blast Furnaces and Allied Steel Mill Equipment"
"The Manufacture of Oxygen in Large Quantities for Industrial Uses"
"Iron Ore Reserves of the Mesabi Range"
"Rust Inhibited Oils for Circulating Systems"
"Rust Preventive Compounds"
Half-Day Symposium on Soluble Oils in the Steel Industry
Half-Day Symposium on Safety in Steel Plants
"Stretch Reducing of Tubular Products"
"Modern Seamless Tube Mills"
"Rod Mills and Rod Mill Roll Design"
"Roller Leveling"
"Corrugating"
"Sodium Hydride Pickling"

In addition to the above papers, which will be presented at the technical meetings, over 150 manufacturers of steel mill equipment will exhibit their latest developments in equipment and service in the Iron and Steel Exposition. Both the meetings and the Iron and Steel Exposition will be held under one roof in the Cleveland Public Auditorium. The social functions will be held in the Hotel Statler.

REMEMBER THE DATES: OCTOBER 1, 2, 3, 4, 1946

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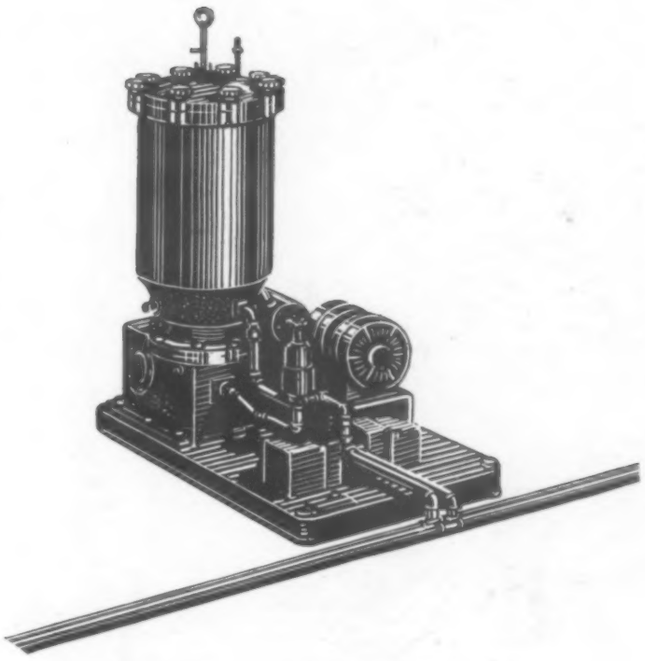

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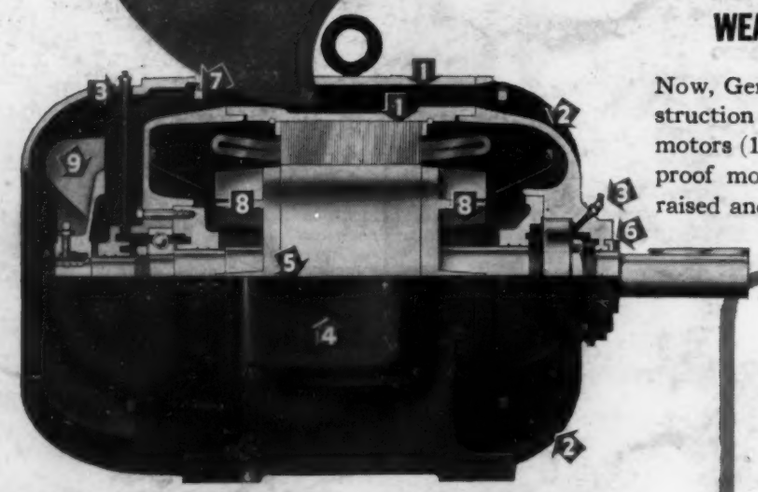

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